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Further new showers found in CMN and SonotaCo databases
The UK Meteor Observation Network
April–May video meteors

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Preliminary results

Front cover photo

This very bright fireball was photographed on 2013 September 28 at $03^{\rm h}33^{\rm m}$ UT from Faith Ranch, Jewett, OH, USA. Nikon D7000 equipped with 8-mm lens at $f/5.6$ was used for this 30 s exposure at ISO 2000. Photo courtesy: Angela McClain.

Writing for WGN This Journal welcomes papers submitted for publication. All papers are reviewed for scientific content, and edited for English and style. Instructions for authors can be found in WGN **31:4**, 124–128, and at `http://www.imo.net/docs/writingforwgn.pdf` .

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Editorial

Javor Kac

We are publishing this issue with substantial delay for which I sincerely apologize. There is some interesting content, including two letters. One of them deals with lessons learned observing minor meteor showers. The other one describes a curious case of a meteoroid mystery which was only solved after the case was handed over for crowdsourcing. The second part of the Croatian Meteor Network search for new showers is presented, uncovering a set of 24 new meteor showers. The UK Meteor Observation Network is introduced, with their current and future plans presented. The August issue is concluded with the IMO Video Meteor Network reports for April and May, which include activity profiles of the Lyrids, η-Aquariids and η-Lyrids.

By coincidence, this issue marks my 36th WGN issue since I started in October 2008, a full 6-volumes worth of our journal. When I started as Editor-in-Chief, I never imagined I would persist that long. I hope you enjoyed reading the journal as much as I did editing it!

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News from the IMO Council

Cis Verbeeck[1]

The International Meteor Organization is an international non-profit organization for and run by (mostly amateur) meteor workers. The most obvious IMO products and activities are probably WGN, the annual International Meteor Conferences, and the IMO website. While these achievements may seem for granted, in fact they are only made possible by the hard work of a devoted group of people, all of them unpaid volunteers. In the previous issue of WGN, the IMO Commissions and their officers were mentioned. Two other IMO officers are the IMC Liaison Officer (Paul Roggemans) and the IMO Outreach Officer (Jure Atanackov). The group of people that actually runs the organization and takes care of the due execution of tasks, is the IMO Council.

As can be read in the IMO Constitution (`http://www.imo.net/imo/constitution`), IMO Council members are elected by the General Assembly and serve a term of four years when elected. At least six months before the term of a Council member expires, the Council sends out to all voting members a Call for Candidates. The IMO Council is presided over by the IMO President, who is also elected to serve a four year term. The Council then elects from its members a Vice-President, a Secretary-General, and a Treasurer. The current Council consists of Cis Verbeeck (President), Jürgen Rendtel (Vice-President), Bob Lunsford (Secretary-General), Marc Gyssens (Treasurer), David Asher, Geert Barentsen, Javor Kac, Detlef Koschny, Sirko Molau, Jean-Louis Rault, and Paul Roggemans.

One of the most important tasks of the Council is to guard the present and future health of the organization in all of its aspects. In this respect, the IMO Council is and should be a representation of the IMO members, with explicitly a lot more members than just the four board members. The Council (and especially the board: President, Vice-President, Secretary General, and Treasurer) have frequent e-mail contact to discuss ideas, challenges, and opportunities, and to take action. When needed, conversation is done by phone. A few times a year, the Council organize a teleconference meeting (i.e., over internet) to follow up decisions and discuss any relevant topics in detail. For instance, Council teleconferences were held on February 11 (present: Geert Barentsen, Marc Gyssens, Javor Kac, Detlef Koschny, Bob Lunsford, Sirko Molau, Jean-Louis Rault, Jürgen Rendtel, Cis Verbeeck) and on May 19 (present: Marc Gyssens, Javor Kac, Detlef Koschny, Bob Lunsford, Sirko Molau, Jean-Louis Rault, Jürgen Rendtel, Cis Verbeeck).

So what did the Council do over the last few months, except communicating actively with meteor workers (just to list a few)? A new edition of the Handbook for Meteor Observers was prepared and will be published at the IMC in Giron. Since the input of visual meteor data has a backlog, the Council issued a call for volunteers in the April issue of WGN, with due response. Since Mike Hankey and Vincent Perlerin volunteered at the IMC in Poznan to create a brand new IMO website, the Council was in frequent contact with them. It was decided to first focus on a new online fireball form, which Mike and Vincent have finished. Thanks to a lot of volunteers, the fireball form — which was introduced at the IMC in Giron — will be available in several languages! At the

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IMC in Giron, a workshop took place about the new IMO website that will be designed and developed by Mike and Vincent and managed by Roman Piffl.

If you've got any questions, suggestions, or problems related to IMO or meteor work, the Council is there to listen to you. You are very welcome to contact any Council member. In case you have no idea whom to contact, feel free to mail me at cis.verbeeck@scarlet.be.

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Letter — Confusion about 255P/Levy meteors erroneously labelled as December Phi Cassiopeiids and minor shower challenges in general

Paul Roggemans[1]

In the 1970s a revival of visual meteor observing inspired many amateur astronomers to discover the challenges and satisfaction of meteor astronomy. In that time the general knowledge of meteoroid streams was to a large extent based on a dataset of meteor orbits as small as 413 orbits derived by Fred Whipple during the Super Schmidt Meteor Camera project (Jacchia et al., 1965). Older meteor publications often referred to the famous British meteor observer William Frederick Denning, a life time visual meteor observer who believed in rather controversial theories. One of his contested believes was that 4 meteors observed in a single night were sufficient proof for a shower radiant if their backwards produced trails intersected in a small area at the sky (Denning, 1899). Applying his methodology for many years, he produced long lists of minor shower radiants which were already in that time considered with a lot of skepticism. Until about 30 years ago the amateur meteor observer community depended mostly on these out-dated and not very reliable sources.

In these circumstances a British amateur, R.A. MacKenzie, recycled the 19th century minor shower controversy into his British Meteor Society Radiant Catalogue. While he was not taken seriously in his own country, he managed to convince the young and unexperienced meteor observers abroad to accept his radiant catalogue as a standard reference. Observers were asked to determine shower activity for each of all these radiant positions by counting the number of meteor trails which backwards produced trails passed within 2° from the radiant position. It did not take long before this observing method was questioned. A simple experiment by randomly throwing sewing needles on a gnomonic plotting map with the many minor shower radiants, the needle point defining the meteor direction, showed that any random generated meteor by accident lined up with one or more radiants on the star map. In an attempt to calculate trajectories from visually plotted meteors in 1982, the author concluded that in almost all cases there was no connection at all between the assumed single station radiant association and the real double station radiant. Moreover the plotting errors proved too unreliable to do any statistical relevant meteor association for very low activity levels. Visual shower associations proved statistical reliable for a very limited number of well-established showers with a sufficient activity level and specific characteristics (angular velocity, trails, etc.).

Unreliable observing instructions are fatal for the motivation of dedicated observers. Many enthusiast visual meteor observers quit when they heard that they had been wasting their time on a completely unfounded methodology. The British Meteor Society as single man society suddenly disappeared when its director R.A. Mackenzie decided to dedicate his life to his other passion; religion. The impact of his religion-like believe in visual observing of minor meteoroid streams was devastating for several meteor observing teams. It was a lesson for the future that in no way the enthusiasm of volunteers should be fooled with irresponsible observing projects and or methodologies. This experience explains why great care was taken to include only a statistical relevant selection of meteor showers in the early VMDB radiant list and the IMO Meteor Shower Calendar.

In 2006 a Task Group on Meteor Shower Nomenclature was established within the IAU Commission 22. This task aimed to uniquely identify all existing meteor showers and establish unique names: such a definitive catalogue should facilitate the establishment of associations between meteor showers and parent bodies among the many Near-Earth Objects that are being discovered. As new meteor observing techniques produced large numbers of meteor orbits, many orbits proved to be dispersed remnants of meteoroid streams. Meanwhile the working list of meteor showers has grown by many hundreds of minor showers. Beyond this list of confirmed and assumed minor meteor showers, theoretical meteoroid stream modelling add predicted theoretical meteor radiants. This wealth of possible radiant activity may be confusing for the amateur visual observer. Which meteor radiants are statistically relevant for visual observations? No straight forward answer is possible as minor stream radiants may display some unpredicted outbursts and newly announced as well as unexpected radiants may suddenly display

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Table 1 – Orbital data for the DPCs detected by CAMS (Jenniskens, 2012) and Andromedids detected by CMOR (Wiegert et al., 2013).

Source	RA (°)	Dec (°)	a (AU)	q (AU)	e	i (°)	Ω (°)	ω (°)
CMOR	18.2 ± 2.6	$+57.4 \pm 2.2$	3.78 ± 0.71	0.902 ± 0.012	0.76 ± 0.04	18.3 ± 1.0	253.5 ± 2.4	216.3 ± 3.1
CAMS	19.3	+58	—	0.896 ± 0.008	0.71 ± 0.05	18.1 ± 1.3	251.9 ± 1.5	218.7 ± 1.6

Table 2 – Orbital data for the ACPs detected by CMN (Šegon et al., 2014) and the theoretical radiant predicted for comet 255P/Levy (Vaubaillon, 2013).

Source	RA (°)	Dec (°)	a (AU)	q (AU)	e	i (°)	Ω (°)	ω (°)
CMN (ACP)	318	+64	—	0.979	0.635	22.9	281.0	181.7
Vaubaillon	332.8	+55.8	—	—	—	—	—	—
255P/Levy	—	—	—	1.008	0.668	18.3	279.7	179.7

some activity. This provides a risk that visual observers repeat the mistakes made 35–40 years ago with the BMS Radiant Catalogue by observing statistical irrelevant minor shower activity.

With the rapidly growing list of minor showers and more frequent predictions for enhanced activity the new and less experienced visual meteor observers risk to get confused. The need for decent information was illustrated with the announcement for a possible meteor shower caused by the dust trail of comet 255P/Levy on 2012 December 31 from a radiant position at RA = 333° and Dec = +56° with very slow meteors (V_g = 13.5 km/s) (Vaubaillon, 2013). For reasons that remain unexplained this theoretical predicted radiant erroneously got the name of the December Phi Cassiopeiids (DPC), a complete different shower RA = 20°, Dec = +58°, V_g = 16.4 km/s) active only in the first week of December (Jenniskens, 2012). The detection of the Andromedids by the Canadian Automated Meteor Observatory during 2011 December 3–5 matched with numerical simulations for particles ejected at the 1649 perihelion passage of 3D/Biela (Wiegert et al., 2013). The coincidence of the CAMS and CMOR data is a school example to illustrate the association of meteor orbit data with a parent object.

To make the mix-up complete, some star maps occurred on the internet with the DPC radiant position (RA = 19°, Dec = +58°) mistaken for the complete different predicted radiant position of December 31 (RA = 333°, Dec = +56°). Focused on the radiant name instead of the real radiant position a completely wrong radiant position was suggested to the observers. In some way this was a good test to verify the reliability of the amateur observers community as no activity should have been reported from the invalid DPC radiant that was plotted by mistake instead of the real predicted radiant. Indeed all reports proved negative: no December Phi Cassiopeids were reported, except by one amateur who claimed having recorded DPC meteors both visually and by photography. This shows the risk for incorrect interpretations of chance lined-up sporadics with any assumed radiant position, in this case the erroneous DPC radiant. Lack of experience, auto-suggestion and too much imagination can produce "evidence" for any assumption. The photographic proofs in this case were no more than some undocumented astrophotos, without any timing, astrometry or positional data which is much a pity in our today's world of electronics.

The really reliable resources to determine any activity are the many well calibrated video camera networks. The Croatian Meteor Network reported indeed no DCPs around December 31 but some barely detectable orbit coincidences were identified as Alpha Cepheids (539 ACP) (Šegon et al., 2014), which correlate well with the predicted meteoroid stream of Vaubaillon (see Table 2).

The main conclusion from the erroneous DPC alert is that most observers proved to be reliable and reported nihil activity for this fake radiant while the CMN effectively recorded orbits related to the true radiant while the visual hourly rates were far below the threshold for statistical relevant hourly rates. Although in this case only one amateur believed having counted meteors for the fake radiant position, care should be taken to inform amateurs properly about the probability of any enhanced activity and the threshold that makes the difference between the statistical significant activity level on one hand and counting pure by chance lined-up sporadics on the other hand. Secondly, although a meteoroid stream name should be a unique label to identify each meteoroid stream, observers should always check the real radiant position and not just look at a name to copy data without verification. Clear instructions should inform less experienced observers and amateurs with a unhealthy fantasy about their observing skills and about the statistical significance of visual radiant associations. Third, the growing meteor shower list, most of which will never produce any statistical significant visual rates, should be used with care remembering the time wasted on visual observing of phantom radiants end 19th century by W.F. Denning and later by R.A. Mackenzie who resumed this mistake in the 1970s.

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Letter — Skydiver nearly hit by stone

Steinar Midtskogen[1] *and Trond Erik Hillestad*[2]

Shortly after deploying his parachute, a Norwegian skydiver filmed a stone shooting by at high speed. Could it be the first ever meteorite filmed in its dark flight?

The story begins on sunny day on 2012 June 17. During a jump from an airplane over Eastern Norway, Mr. Anders Helstrup deploys his parachute about 1000 meters above the ground. Seconds after, he notices *something* that apparently passes him at great speed. After landing, he checks his two helmet video cameras, and finds a dark stone hurtling by, presumably only meters away.

Figure 1 – Montage showing a stone passing by the skydiver Anders Helstrup, having his main parachute fully deployed. Each video frame is separated by 1/30 second. Probably not a meteorite after all, but a jolly exiting story anyway. Photo: Anders Helstrup / Dark Flight. Photo montage created by Hans Erik Foss Amundsen.

There was no one above him, neither planes nor other jumpers, that could have dropped a stone. Helstrup contacts a friend, Morten Bilet, who is an amateur geologist and meteorite hunter. The stone can be seen on seven frames on the helmet forward camera, and also glimpsed on a backward facing camera. They both film in

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full HD (1920×1080 and 30 frames per second). The stone can be seen rotating. It has an albedo that apparently matches a stony meteorite and also something that looks like a fresh fracture surface.

A meteorite has never before been filmed during its dark flight, which occurs after the luminous part of its trajectory and consecutive fragmentation. Meteorites are usually small and fall to the ground with a speed of about 300 km/h, depending on their shape and density. They are virtually invisible and assumed impossible to photograph.

Realising that such a story would be a world sensation, it was decided to keep the story a secret within a limited group of enthusiasts, including selected geologists and astronomers.

The definitive proof of a dark flight-footage would be to actually find a meteorite. The monetary value of such a meteorite would probably be very high, but the group's sole intent is to hand it over to the Museum of Natural History in Oslo, which houses the national collection of meteorites and can organize scientific studies. Norway does not have clear legislation concerning meteorite finds, so the group does not want a meteorite to fall into commercial hands.

The videos were analyzed to find the exact position of both the skydiver and the stone. A possible impact ellipse is narrowed down to less than 100 meters and a number of search parties are organized. The area is fairly easy reachable. However, it consists of forest, marshland, grass and a small creek, and nothing is found for one and a half years.

The group realises it has reached a stand-still. Helstrup decides it's time to get help from the international community and goes public on national television on 2014 April 3. A Youtube version is also made, which is seen by four million people in three days.

The help we received was overwhelming. A very good suggestion came from the physicist Philip Metzger, who calculated a detailed flight path of the stone relative to the parachutist. This made it possible to reconstruct the most likely sequence:

- After the skydiver's previous landing, a small pebble, not exceeding a few centimeters in size, is accidentally trapped in the auxiliary parachute. According to Metzger, this is relatively common. Anders Helstrup then packs his parachute properly on a clean floor. He's an experienced parachutist, but does not realize that a pebble is caught in it.

- Helstrup used a wing suit during the first part of his jump. He fell northward and downward at an angle of about 40 degrees with the ground. As he deploys the auxiliary parachute, the pebble is released, perhaps being bounced upward. Helstrup is still in free fall and quickly increases his distance to the pebble. Then the main parachute folds out. Helstrup makes a 250 degree rotation and the pebble overtakes him, 12 seconds after it was tossed out from the auxiliary parachute.

This is the most likely explanation. However, according to Metzger's analysis, the trajectory is also consistent with a real meteorite that passes 12 to 18 meters away.

The idea that something had been packed into the parachute was not new to us. It had pursued the Norwegian group from the beginning. We could however not explain how a pebble could appear so far above the skydiver, after the main parachute was fully deployed, with the pebble having apparently no acceleration.

The possibility that the rock came from space can still not be completely excluded. However, the probability that a pebble was accidentally packed into the auxiliary parachute, seems several orders of magnitude higher.

Conclusion: Given enough eyeballs, all mysteries are shallow.

More information can be found on the web pages of the Fireball Video Network: Fireballs vs. eyeballs (likely explanation), `http://norskmeteornettverk.no/wordpress/?p=1497`, and Skydiver films falling meteorite (early story), `http://norskmeteornettverk.no/wordpress/?p=1399`.

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Meteor science

Results of CMN 2013 search for new showers across CMN and SonotaCo databases II

Peter Gural[1], *Damir Šegon*[2], *Željko Andreić*[3], *Ivica Skokić*[4], *Korado Korlević*[5], *Denis Vida*[6], *Filip Novoselnik*[7], *and David Gostinski*[8]

This is the second paper (out of three) of a report series presenting the results on the discovery of new meteoroid streams across a variety of video meteor databases. The search method used compared each meteor to all others in the same database that was constructed by combining Croatian Meteor Network databases for 2007 to 2010 and SonotaCo databases for 2007 to 2011. The second set of 24 possible new showers is described in this article.

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1 Introduction

This article is the second in a series of papers describing new meteoroid streams discovered by searching existing video meteor databases and covers 24 possible new showers. A description of the background and processing procedures for the stream search methodology can be found in the first article of the series (Andreić et al., 2014). A file containing all individual orbits of the new showers described in this article can be downloaded from the CMN web page:
`http://cmn.rgn.hr/downloads/downloads.html`

The orbital elements of the new showers discussed herein are summarized in Table 1 as obtained from applying search and discovery tools to the CMN and Sonotaco databases. Each of the showers listed were also successfully tested for detection through an examination of the IMO single station video database.

To conserve space, the radiant plots have been grouped together (Figures 1–3). Values of the generic D-criterion defined as the mean value of $D_{SH}/2$, $D_H/2$ and D_D (with the additional constraint that all three have to be smaller than a preset limit – see Andreić et al. (2014)) are coded as gray scale circles in the figures. Note that in the electronic edition they are color-coded for easier visualization. Additionally, radiants that belong to the new showers are indicated by larger sized circles.

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2 Descriptions of new showers

What follows is a description of each of the 24 new streams discovered, but requiring confirmation before they can be considered 'established' showers by the IAU.

2.1 32 Leonis Minorids (573 TLM)

The video orbit databases contained 27 meteors spread over 13 days which could be associated with this shower 573 TLM. The number of orbits per day averages 2.4, being slightly higher in flux during the first part of the activity period. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from November 16 to December 5, the mean corresponding to November 27.

There are two other radiants that are active at roughly the same solar longitude and close in equatorial coordinates, 339 PSU and 440 NLM. There are no orbital elements for 339 PSU in the IAU MDC, but the new radiant's position is separated by about 8° (mostly in declination) at the moment of mean solar longitude for 339 PSU. Also the difference in geocentric velocities is about 4 km/s, so it is unlikely that they are the same shower. The radiant of 440 NLM has about the same 8° offset the 573 TLM radiant but mostly in right ascension. Since the D_{SH} for these two showers is 0.52, they are clearly different streams.

2.2 γ Ursae Majorids (574 GMA)

21 meteors spread over 11 days are associated with this shower. The number of orbits per day is about 1.9. Apart from a clearly evident daily motion, the radiant plot does not reveal any structure. Active from November 29 to December 9, the mean corresponding to December 4.

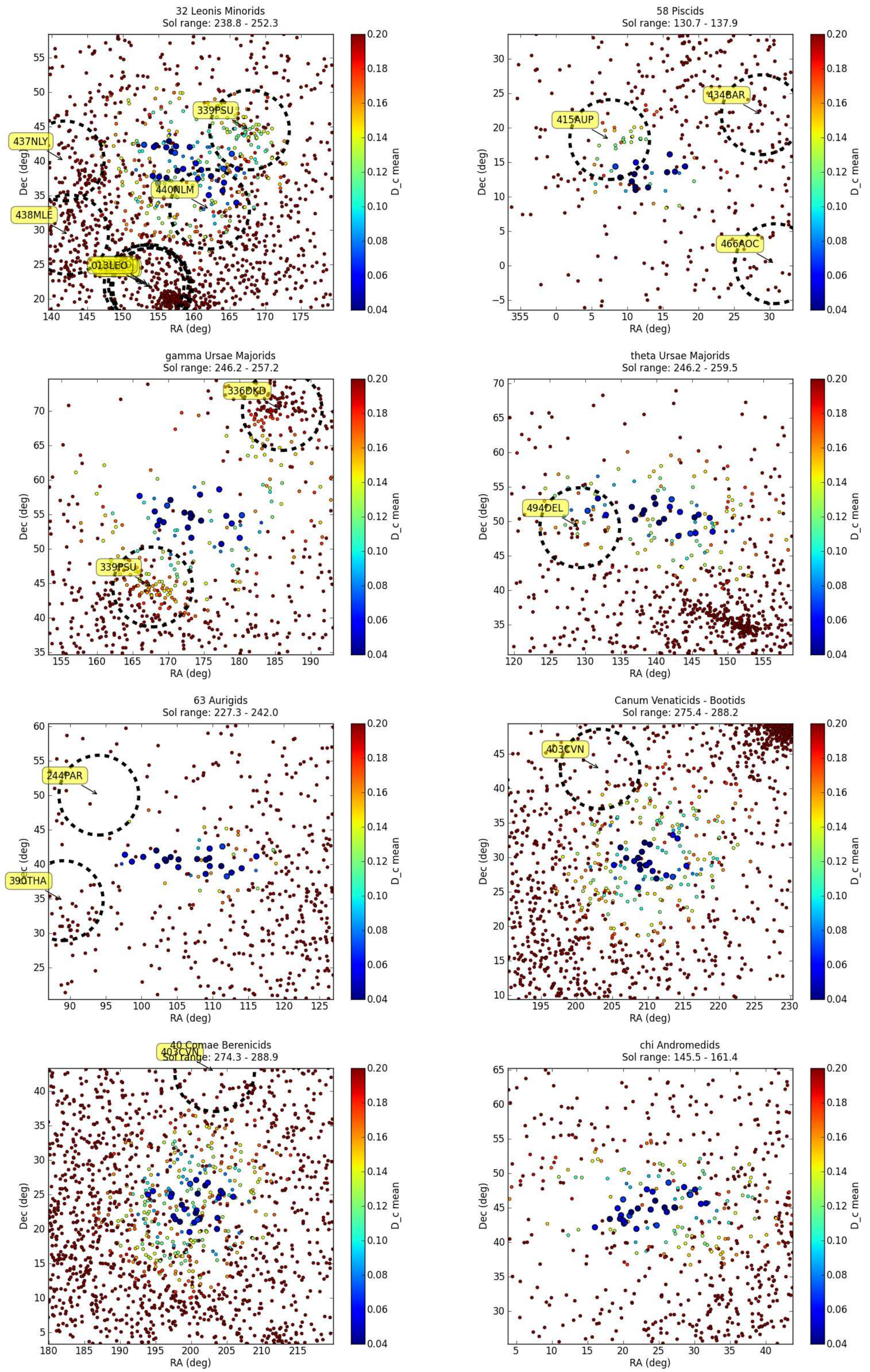

Figure 1 – Radiant plots of showers 573 TLM to 580 CHA.

2.3 63 Aurigids (575 SAU)

22 meteors spread over 14 days are associated with this shower. The number of orbits per day is about 1.6, being slightly stronger in flux around the mean solar longitude. The radiant plot is highly stretched by the daily motion, but does not reveal any structure. Active from November 10 to 22, the mean corresponding to November 18.

2.4 40 Comae Berenicids (576 FOB)

26 meteors spread over 14 days are associated with this shower. The number of orbits per day is about 1.9. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from December 26 to January 9, the mean corresponding to January 3.

2.5 58 Piscids (577 FPI)

13 meteors spread over 7 days are associated with this shower. The number of orbits per day is about 1.9, with flux slightly higher at the beginning of the activity period. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from August 3 to 11, the mean corresponding to August 6. Note that the shower 415 AUP is active at the same time, with the radiants being separated by about 6° and possessing similar geocentric velocities (66 vs. 64.2 km/s). Again, further analysis is not possible due to the lack of orbital elements for the 415 AUP, so we can only conclude that these two showers may be marginally related in some way.

2.6 θ Ursae Majorids (578 TUM)

21 meteors spread over 13 days are associated with this shower. The number of orbits per day is about 1.6. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from November 29 to December 12, the mean corresponding to December 5. Note that 494 DEL is active at the same time, but the radiants are separated by about 11°, so it is highly unlikely that they are identical. A D_{SH} value of 0.41 confirms that this possible new shower cannot be considered the same as 494 DEL.

2.7 Canum Venaticids-Bootids (579 TCV)

21 meteors spread over 13 days are associated with this shower. The number of orbits per day is about 1.6. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from December 28 to January 9, the mean corresponding to January 2.

2.8 χ Andromedids (580 CHA)

29 meteors spread over 16 days are associated with this shower. The number of orbits per day is about 1.8. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from August 19 to September 4, the mean corresponding to August 27.

2.9 90 Herculids (581 NHE)

18 meteors spread over 11 days are associated with this shower. The number of orbits per day is about 1.6. The radiant plot is quite scattered and does not reveal any structure. Active from April 20 to May 7, the mean corresponding to April 28. This shower may be related to 6 LYR, whose radiant is about 11° away, but with a $D_{SH} = 0.30$ they are clearly different showers.

2.10 January β Craterids (582 JBC)

16 meteors spread over 9 days are associated with this shower. The number of orbits per day is about 1.8. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from December 31 to January 9, the mean corresponding to January 4. A possible parent body for this shower is comet C/1092 A1. A D_{SH} of 0.19 indicates the possibility of connection between 582 JBC and this comet. An Earth MOID of 0.05 AU is rather large, but angular orbital elements of the comet and 582 JBC are very similar. Thus, there is clearly a need for dynamical modeling analysis of this comet and its relation to 582 JBC.

2.11 12 Taurids (583 TTA)

37 meteors spread over 21 days are associated with this shower. The number of orbits per day is about 1.8. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from August 27 to September 18, the mean corresponding to September 7.

2.12 Cepheids-Cassiopeiids (584 GCE)

21 meteors spread over 12 days are associated with this shower. The number of orbits per day is about 1.8. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from August 7 to 20, the mean corresponding to August 14.

2.13 33 Hydrids (585 THY)

31 meteors spread over 18 days are associated with this shower. The number of orbits per day is about 1.7. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from December 5 to 23, the mean corresponding to December 14.

2.14 2 Lacertids (586 TLA)

18 meteors spread over 11 days are associated with this shower. The number of orbits per day is about 1.6. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from July 30 to August 11, the mean corresponding to August 5.

2.15 59 Cygnids (587 FNC)

22 meteors spread over 13 days are associated with this shower. The number of orbits per day is about 1.7. The radiant plot does not reveal any structure. Active from August 5 to 19, the mean corresponding to August 10.

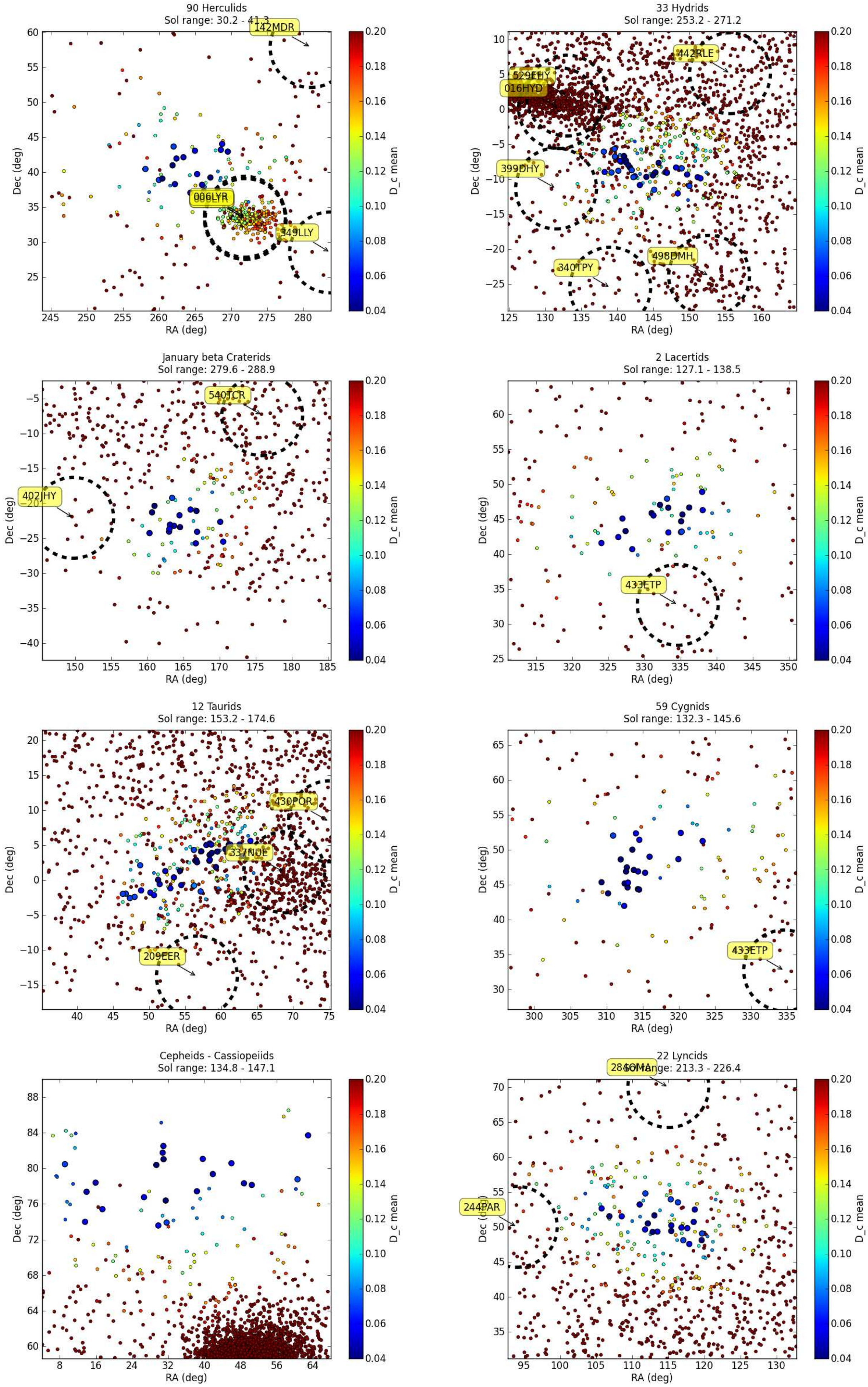

Figure 2 – Radiant plots of showers 581 NHE to 588 TTL.

2.16 22 Lyncids (588 TTL)

22 meteors spread over 13 days are associated with this shower. The number of orbits per day is about 1.7. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from October 27 to November 9, the mean corresponding to November 3.

2.17 50 Cancrids (589 FCA)

32 meteors spread over 19 days are associated with this shower. The number of orbits per day is about 1.7. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from November 18 to December 7, the mean corresponding to November 28.

2.18 10 Canum Venaticids (590 VCT)

20 meteors spread over 12 days are associated with this shower. The number of orbits per day is about 1.7. Apart from daily motion, radiant plot does not reveal any structure. Active from January 6 to 18, the mean corresponding to January 11.

2.19 ζ Bootids (591 ZBO)

23 meteors spread over 14 days are associated with this shower. The number of orbits per day is about 1.6. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from February 8 to 22, the mean corresponding to February 16. Note the radiant of 34 DSE is about 10° away, but with a D_{SH} of 0.78 we are dealing with two clearly different showers.

2.20 91 Piscids (592 PON)

22 meteors spread over 14 days are associated with this shower. The number of orbits per day is about 1.6. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from August 2 to 17, the mean corresponding to August 9.

2.21 28 Lyncids (593 TOL)

28 meteors spread over 18 days are associated with this shower. The number of orbits per day is about 1.6. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from October 28 to November 15, the mean corresponding to November 5.

2.22 Serpentids-Coronae Borealids (594 RSE)

17 meteors spread over 11 days are associated with this shower. The number of orbits per day is about 1.5. The radiant plot is compact and does not reveal any structure, apart from effects of daily motion. Active from January 13 to 24 the mean corresponding to January 19.

2.23 13 Taurids (595 TTT)

29 meteors spread over 20 days are associated with this shower. The number of orbits per day is about 1.5. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from September 6 to September 27, the mean corresponding to September 18.

2.24 78 Ursae Majorids (596 MUS)

17 meteors spread over 13 days are associated with this shower. The number of orbits per day is about 1.3. Apart from the clearly evident daily motion, the radiant plot does not reveal any structure. Active from January 1 to 14, the mean corresponding to January 6.

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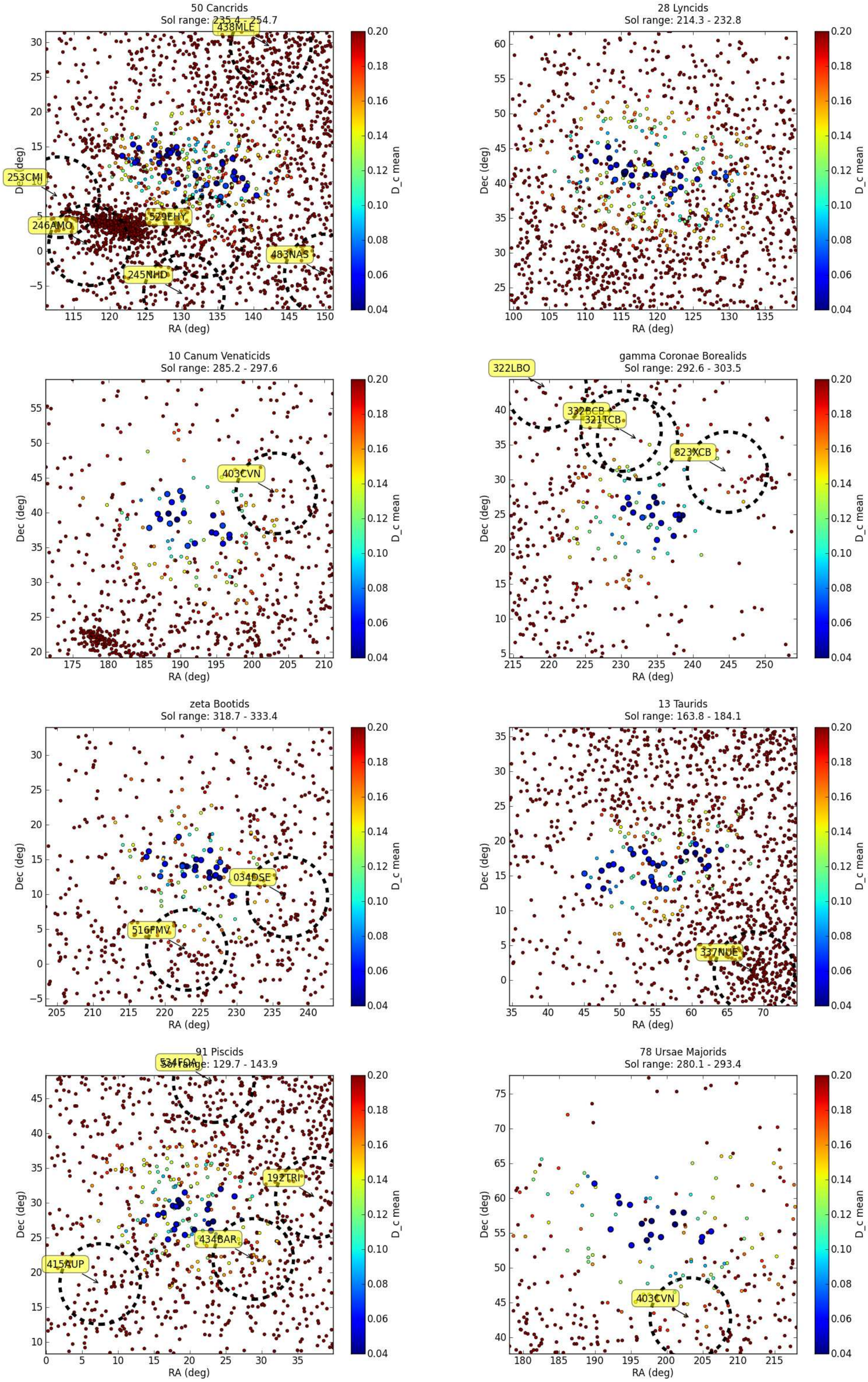

Figure 3 – Radiant plots of showers 589 FCA to 596 MUS.

Table 1 – Mean orbits of the newly discovered showers. The columns labeled ID and name are the IAU's identification and name of the shower; $\lambda_\odot$ solar longitude range of the orbits covering the active period; $\overline{\lambda_\odot}$ average solar longitude; RA and DEC are the equatorial coordinates of the mean radiant; dRA and dDEC are the daily motion of the radiant's drift in RA and DEC; v_g is the geocentric velocity in km/s; q perihelion distance in AU, e eccentricity; ω argument of perihelion; Ω longitude of the ascending node; i inclination; and N is the number of associated orbits. The error values are one standard deviation of the corresponding parameter. In the case of RA and DEC, there is a contribution of the daily motion to the dispersion of the radiants. All angular values are given in degrees.

ID	name	$\lambda_\odot$	$\overline{\lambda_\odot}$	RA	DEC	dRA	dDEC	v_g	q	e	ω	Ω	i	N
573 TLM	32 Leonis Minorids	239–252	245	159.1 ± 4	39.1 ± 2.5	0.84	−0.35	64.4 ± 0.8	0.925 ± 0.019	0.880 ± 0.052	209.7 ± 4	244.9 ± 4	130.6 ± 3.5	27
574 GMA	γ Ursae Majorids	246–257	252	173.3 ± 4	54.7 ± 2.0	1.17	−0.37	54.4 ± 1.3	0.918 ± 0.014	0.891 ± 0.046	211.2 ± 3	251.7 ± 3	98.7 ± 3.0	21
575 SAU	63 Aurigids	227–242	235	107.0 ± 5	40.4 ± 1.1	1.22	−0.07	56.5 ± 0.8	0.222 ± 0.013	0.980 ± 0.017	304.6 ± 2	235.4 ± 4	119.8 ± 3.3	22
576 FOB	40 Comae Berenicids	274–289	282	200.4 ± 3	23.5 ± 2.2	0.65	−0.24	64.6 ± 1.1	0.975 ± 0.007	0.878 ± 0.051	189.6 ± 5	282.2 ± 4	129.0 ± 3.8	26
577 FPI	58 Piscids	131–138	134	12.6 ± 3	13.4 ± 1.5	1.16	0.38	64.2 ± 0.7	0.486 ± 0.018	0.954 ± 0.034	273.9 ± 2	133.8 ± 2	163.4 ± 3.3	13
578 TUM	θ Ursae Majorids	246–259	253	140.6 ± 5	50.9 ± 1.6	1.30	−0.24	54.8 ± 1.3	0.535 ± 0.022	0.965 ± 0.047	266.1 ± 3	253.2 ± 3	101.3 ± 3.0	21
579 TCV	Canum Venaticids-Bootids	275–288	282	210.1 ± 3	29.4 ± 2.0	0.69	−0.17	59.9 ± 1.1	0.977 ± 0.005	0.861 ± 0.047	171.6 ± 4	281.8 ± 3	113.7 ± 3.3	21
580 CHA	χ Andromedids	145–161	154	23.9 ± 4	45.0 ± 1.8	0.92	0.31	58.9 ± 1.0	0.750 ± 0.028	0.923 ± 0.052	242.4 ± 4	153.6 ± 4	117.0 ± 2.5	29
581 NHE	90 Herculids	30–41	38	264.3 ± 3	40.3 ± 2.4	0.50	0.19	39.0 ± 1.7	0.912 ± 0.023	0.929 ± 0.053	216.3 ± 5	37.6 ± 3	62.9 ± 3.1	18
582 JBC	January β Craterids	280–289	284	164.6 ± 3	-22.8 ± 1.8	0.80	−0.30	63.8 ± 0.8	0.793 ± 0.025	0.922 ± 0.046	53.4 ± 4	103.8 ± 3	129.4 ± 3.0	16
583 TTA	12 Taurids	153–175	164	55.5 ± 5	1.8 ± 2.7	0.80	0.39	65.2 ± 0.8	0.707 ± 0.032	0.954 ± 0.043	67.2 ± 4	344.1 ± 6	146.0 ± 3.3	37
584 GCE	Cepheids-Cassiopeiids	135–147	141	33.3 ± 15	78.5 ± 2.8	2.85	0.42	45.6 ± 1.4	0.972 ± 0.014	0.888 ± 0.045	156.3 ± 4	140.8 ± 4	79.1 ± 3.2	21
585 THY	33 Hydrids	253–271	262	143.8 ± 4	-8.7 ± 1.5	0.71	−0.18	64.9 ± 1.0	0.676 ± 0.041	0.980 ± 0.051	68.4 ± 5	81.9 ± 5	136.5 ± 2.6	31
586 TLA	2 Lacertids	127–138	133	332.2 ± 4	44.8 ± 2.2	0.63	0.53	44.0 ± 1.6	0.768 ± 0.023	0.923 ± 0.038	240.4 ± 3	132.8 ± 3	74.1 ± 3.9	18
587 FNC	59 Cygnids	132–146	137	314.2 ± 3	47.5 ± 3.0	0.23	0.57	35.3 ± 1.5	0.852 ± 0.024	0.931 ± 0.040	227.8 ± 4	137.0 ± 3	54.4 ± 3.0	22
588 TTL	22 Lyncids	213–226	220	114.3 ± 4	50.8 ± 2.0	1.02	−0.24	60.6 ± 1.1	0.710 ± 0.030	0.892 ± 0.056	246.6 ± 4	220.1 ± 3	122.9 ± 3.3	22
589 FCA	50 Cancrids	235–255	245	131.3 ± 5	11.9 ± 2.2	0.87	−0.27	66.6 ± 0.8	0.528 ± 0.034	0.965 ± 0.046	86.9 ± 4	65.4 ± 6	167.4 ± 3.3	32
590 VCT	10 Canum Venaticids	285–298	291	191.3 ± 3	38.8 ± 2.3	0.75	−0.26	54.9 ± 1.3	0.724 ± 0.022	0.908 ± 0.048	243.6 ± 3	291.1 ± 4	101.0 ± 3.7	20
591 ZBO	ζ Bootids	319–333	327	224.2 ± 3	13.9 ± 1.7	0.72	−0.23	62.5 ± 1.1	0.785 ± 0.029	0.933 ± 0.057	234.9 ± 4	327.2 ± 4	124.4 ± 2.7	23
592 PON	91 Piscids	130–144	136	19.6 ± 3	28.4 ± 2.0	0.75	0.37	64.8 ± 1.0	0.788 ± 0.027	0.891 ± 0.051	238.2 ± 4	136.3 ± 3	144.7 ± 3.7	22
593 TOL	28 Lyncids	214–233	223	118.5 ± 5	41.6 ± 1.5	0.99	−0.13	65.1 ± 0.9	0.716 ± 0.035	0.944 ± 0.053	244.6 ± 5	222.6 ± 5	140.1 ± 2.7	28
594 RSE	Serpentids-Coronae Borealids	293–303	298	234.9 ± 3	25.1 ± 1.6	0.71	−0.20	56.6 ± 1.0	0.902 ± 0.017	0.917 ± 0.046	145.9 ± 4	298.4 ± 3	103.7 ± 2.1	17
595 TTT	13 Taurids	164–184	175	55.1 ± 5	16.1 ± 1.9	0.92	0.16	64.5 ± 0.9	0.434 ± 0.029	0.974 ± 0.038	98.8 ± 4	354.8 ± 6	172.2 ± 3.9	29
596 MUS	78 Ursae Majorids	280–293	286	198.1 ± 5	56.6 ± 2.5	0.96	−0.43	45.2 ± 1.5	0.865 ± 0.021	0.911 ± 0.037	221.5 ± 4	285.8 ± 4	75.6 ± 3.0	17

Preliminary results

The UK Meteor Observation Network

Peter Campbell-Burns[1] *and Richard Kacerek*[2]

This report introduces the UK Meteor Observation Network, an innovative collaboration that brings together amateur astronomers in the UK with a common interest in recording meteor activity and provides them with a platform through which experience, expertise and data can be shared. The background to UKMON, its aims and how it operates are discussed, and the importance of raising awareness, education and ongoing public engagement are highlighted. To demonstrate data gathering potential of UKMON counts of detected meteors by stream for 2013 are presented. This report concludes with an overview of the many projects which UKMON hopes to undertake in 2014/15.

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1 Introduction

The UK Meteor Observation Network is one of many collaborative projects worldwide using CCTV technology to collect data on meteor activity. What sets UKMON apart from these other collaborations is both its emphasis on raising public awareness and public engagement, and also its operating framework which is intended to encourage and facilitate collaboration between its members. These, and the background to the project, are discussed in more detail in this report. The general principles of CCTV meteor detection and data pipeline have been discussed in previous papers and are not discussed further.

2 What is UKMON?

A simple elevator pitch would describe UKMON as an innovative partnership that promotes CCTV observation of meteor activity over the UK. It brings together amateur astronomers who share a common interest in recording meteor activity and provides them with a platform through which they can share their experience, expertise and data. Although it is coordinated by a small core team, it runs on democratic principles with its priorities determined by its members. UKMON does not own the data or any report generated from the data.

UKMON is not the only network in the UK using CCTV to acquire meteor data and although it shares many common goals and objectives, UKMON is attempting to be different by:

- Informing and educating the public, raising awareness and encouraging people to look out for and report meteors;
- Promoting CCTV meteor observation and encouraging participation by providing extensive help and support to individuals and groups;
- Providing an operating framework and infrastructure that enables members to work together, exchange observational data and engage with the general public;
- Providing an active forum through which members can discuss ideas and share their knowledge and experience;
- Establishing a strong web and social media presence to raise awareness, promote UKMON, and encourage participation. UKMON has been innovative, especially in its approach to public engagement, and it continues to look for new ideas.

3 A brief history

In late 2011 a handful of individuals in the UK were using CCTV to observe meteors but his method of observation was neither widely known about nor well understood by the amateur astronomy community. Encouraged by members of the Central European Meteor Network (CEMeNt) community in the Czech Republic, a CCTV meteor observation station was set up in Ash Vale, Surrey, by Richard Kacerek. This single station was pointed towards northern France with the expectation that matching observations would be found in the BOAM database. Although the number of matches was relatively small, the detail and quality of the resulting analysis generated much interest amongst the local astronomy community. Such was the level enthusiasm that Richard Kacerek and Peter Campbell-Burns established UKMON with the aim of building a UK-wide network.

UKMON's first success was in late 2012 when it was invited to present at a quarterly meeting of the Southern Area Group of Astronomical Societies (SAGAS), a regional body that represents around 20 astronomy societies in the South of England. The presentation encouraged Hampshire Astronomical Group to join UKMON and two stations were established at its Clanfield Observatory. This was UKMON's first opportunity to acquire multi-station observations from cameras based solely in the UK.

By Autumn 2013 UKMON had exceeded its growth target and with membership having reached a 'critical

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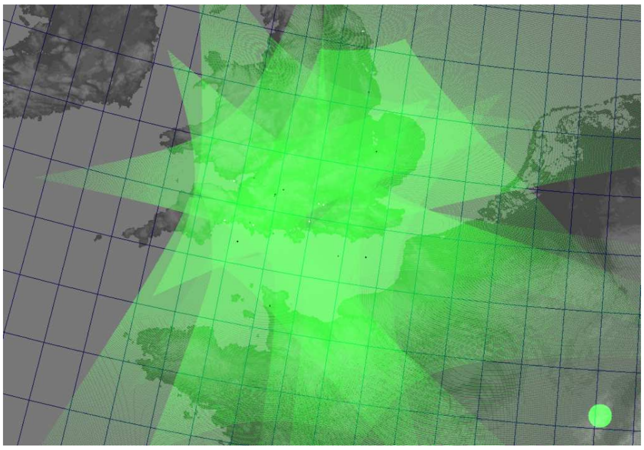

Figure 1 – UKMON Sky Coverage as of 2014 January 1.

mass', UKMON convened its first collaboration meeting which was hosted by the S.P.A.M. detection group at the Norman Locker Observatory. This meeting was well attended by members of UKMON (see group photograph in Figure 4 at the end of this report).

15 cameras are now operational with another 3 due to go on line. A summary list of members is shown in Table 1 and a full list of participants is provided in the acknowledgements at the end of this paper. The overall sky coverage as of 2014 January 1 is shown in Figure 1.

Table 1 – UKMON Members as of 2014 April 1.

Station	No. of Cameras
Cardiff Astronomical Society	2
Farnham Astronomical Society	1
Richard Fleet (Newbury AS)	3
Hampshire Astronomical Group	2
Richard Kacerek	2
Scarborough and Ryedale Astro. Society	1
Solar, Planetary & Meteor Detection Group	2
Steve Hooks	2
Barry Lorimer	2*
John Maclean (Independent)	1*

* Set up in progress but cameras not yet operational

UKMON works closely and share data with other networks in Europe and is now the second largest contributor to the EDMOND database.

4 Choosing the technology

UKMON was open to any interested individual or astronomy society, but wishing to encourage wider participation a broader catchment (including schools and colleges) was considered. To make set-up as easy as possible and to keep entry costs within reach of those with a limited budget it was important that the components of a basic monitoring station were both readily available and affordable. Although MetRec (by Sirko Molau) was a well-established solution it did not meet UKMON's criteria and was rejected in favour of the Sonotaco suite. In particular, MetRec required a more expensive CCTV camera and its use of out of production video decoders risked problems with the supply of equipment. The Sonotaco UFO suite offered three advantages:

- Despite software licensing costs the overall setup cost was lower,
- Compatibility with a wide range of video decoders ensured an easy and reliable supply chain for low cost CCTV cameras and decoders, and
- UKMON data would be directly compatible with networks across Europe also using UFO Suite.

The UFO suite has delivered very good results with cameras costing a little over £25 per unit. A basic CCTV camera, auto-iris lens and decoder can be obtained for under £100. Note that UFO Suite is compatible with more sensitive CCTV cameras such as Watec and therefore UKMON members would be not constrained to using low cost cameras.

5 The UKMON operating framework

As more groups and individuals joined UKMON solutions had to be found to a number of problems:

- Instructing new members unfamiliar with the UFO Suite on acquisition, analysis and the overall data pipeline.
- Managing data quality and ensuring minimum quality standards for operation and data processing.
- Sharing the large volume of data generated by an increasing number of cameras.
- Alerting members (and the public) when a significant event has occurred.
- Communicating UKMON activity to the general public.

Solutions to these problems led to the development of a framework comprising four key operating elements provided and managed by the core team:

- Guidelines and support,
- Central data archive,
- UKMON Live, and
- UKMON website and social media management.

Each of these four elements is described below. Figure 2 shows the overall operating framework.

5.1 Guidelines and support

Members of UKMON are connected to a significant pool of expertise that spans international borders. UKMON works in close collaboration with networks across Europe as well as a new network operating in Brazil, and is able to benefit from their collective expertise. The support provided by UKMON extends to supplying new members with cameras, lenses and cabling (at cost) as well as advice on how to source enclosures and mounting hardware. UKMON also advises on setting fields

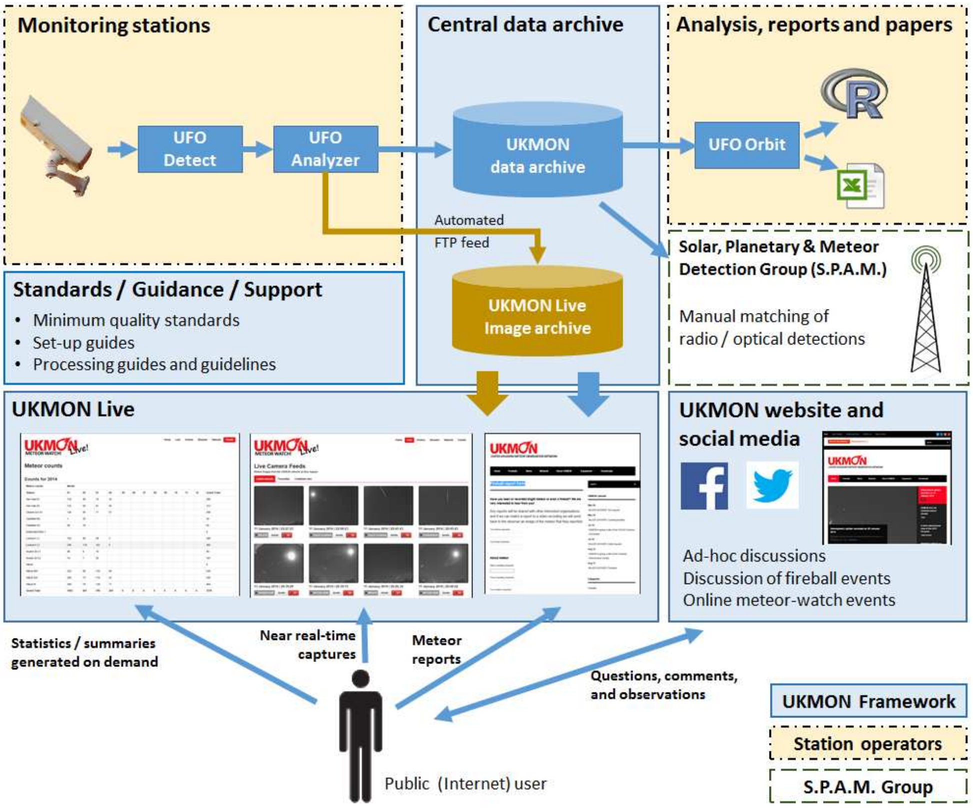

Figure 2 – UKMON operational framework, current state.

of view to ensure optimal positioning for multi-station detection.

To ensure accuracy and consistency of results it is important that all stations in the UKMON network are set up correctly and that subsequent processing of video clips is performed to a minimum standard across the UKMON network. UKMON has already published a number of guides to its members which define settings and further guidance is planned.

5.2 Central data archive

Meteor data is only of value if it is accessible and its value is increased by aggregation. Data that is distributed across individual members is neither easily discoverable nor accessible and therefore the logical choice was to implement a central / shared data archive. This archive is now core to UKMON's operation.

The archive is an ISP-hosted repository to which members upload their processed data. Each member has their own account and a dedicated directory structure within the archive, the organisation of which mirrors the default UFO Detect directory tree. AVI video files are not yet uploaded due to cost constraints and the configuration of file type filters within the ftp client still allows upload to be performed as a simple directory level drag and drop. Members are encouraged to process and upload data in a timely manner so that the currency of data is ensured.

Open sharing of meteor data within the collaboration (and with any organization with a sound scientific case for use of UKMON data) is a fundamental principle. Once data uploaded onto the central archive it is available to the collaboration, but ownership of meteor data remains with contributor. By using the archive contributors agree to the making their data available to interested parties on the understanding that appropriate attribution is given.

5.3 UKMON website and social media management

Communicating science to the public was a principle aim of UKMON from the outset. The high level of interest shown by UKMON's following on Twitter confirmed the value in opening up UKMON, sharing significant observations and making the science more transparent and accessible to everyone. UKMON has used the Internet and social media to good effect to generate interest in meteors, to engage with the public and media, and to encourage participation in citizen science.

A website was set up to promote UKMON[1] and a Twitter account to enable two-way dialogue with the public. This has been highly successful and UKMON's twitter following has already exceeded 3 500. The public response has been remarkable; a significant fireball event often sparks a flurry of tweets and up to 150 new followers have signed up within hours. Tweets include questions, comments and members of the public contributing their own observations.

The UKMON website also features a form for the public to report fireballs. All reports are shared with relevant organizations with an interest in public reports. However, UKMON endeavors to make this a two way dialogue. If UKMON has recorded a meteor matching

[1] www.ukmeteornetwork.co.uk

a reported observation then an image of the meteor will be returned to the individual making the report.

UKMON will continue to invest significant time, effort in communication and public engagement (see Current projects and future plans).

5.4 UKMON Live

Overwhelmed by the level of interest in meteors UKMON needed a better way to involve the public and encourage them to observe meteors. An initial idea to share images of meteor events as they are recorded (near real-time) led to the launch of UKMON Live[2]. UKMON Live is an Internet service providing coverage of major shower events such as the Perseids and Geminids. As soon as any participating station in the network detects a meteor a composite image is streamed directly to UKMON Live for publication. Users can view latest meteors or filter views to show meteors for only selected showers, locations and / or date ranges. Users can even compare views from two stations and vote for their favorites (this feature was added experimentally to encourage user participation).

Launched in time for the 2013 Perseids, and with just two days' to promote the service UKMON Live saw over 7 000 unique visitors in the six hour period either side of peak meteor activity and as many as 800 visitors on the site at any one time. UKMON was not aware of this being attempted by any other meteor observation (and this may be a world first).

6 A summary of 2013, UKMON's first full year of operation

In 2013 cameras in the UKMON network made more than 13 700 individual meteor observations covering 38 known streams (see Table 2). Geminid meteors make up the largest single stream population but this also reflects the network status where, in 2013 December, UKMON had more cameras operational (and more sky coverage) than at any other time in 2013.

Match rates are seen to vary significantly by shower from less than two percent to over 20 percent with two major showers having the highest number of matches. Factors affecting match rates could include variation in weather conditions across the country and affecting sites differently, variation in number of cameras operational at any given time and average brightness of the shower.

Throughout 2013 priority was given to growing the network of cameras development of UKMON infrastructure and consequently only summary statistics and reports have been produced.

Table 2 – Meteor counts by stream (IAU 3-letter code). The Single Observations column shows (a) the number of individual detections across all UKMON stations and (b) Matched Observations column shows the number of meteors where there is a unified observation of a meteor by two or more stations. The match rate is (b) as a percentage of (a).

Stream	Single obs.	Matched obs.	Match rate
Spo	5 812	1 009	17.4%
GEM	2 012	436	21.7%
PEP	1 779	343	19.3%
COM	391	39	10.0%
LEO	338	27	8.0%
HYD	336	46	13.7%
NTA	325	29	8.9%
STA	310	22	7.1%
ORI	276	19	6.9%
DAD	236	27	11.4%
NOO	236	16	6.8%
SPE	189	22	11.6%
KCG	126	9	7.1%
PSU	122	3	2.5%
MON	116	5	4.3%
KDR	93	4	4.3%
URS	88	3	3.4%
BPI	81	4	4.9%
CAP	79	4	5.1%
SDA	77	7	9.1%
OER	62	4	6.5%
AHY	57	—	—
AND	56	1	1.8%
ETA	53	5	9.4%
OCU	53	—	—
LMI	49	—	—
OCT	48	3	6.3%
QUA	41	3	7.3%
TPY	39	—	—
XVI	38	—	—
LYR	36	1	2.8%
NUE	34	1	2.9%
ERI	32	—	—
PAU	31	2	6.5%
JUG	29	—	—
ELY	12	—	—
EVI	11	1	9.1%
HVI	9	—	—
XUM	3	—	—
Total	13 715	2 095	15.3%

6.1 Sprite activity

UKMON is contributing to research on Sprites with by sharing its observations with the University of Bath. UKMON recorded the first optical sprite observation independently confirmed by radar (Sprite observed near Hull on 2013 July 23). More significantly, the Ash Vale, Clanfield and Wilcot stations have recorded sprites on more than one occasion with significant sprite activity over the English Channel. On the same night that that UKMON detected the first verified sprite Clanfield recorded 9 sprites on one evening suggesting that these are more common events than was once believed.

7 Current projects and future plans

UKMON is exploring the potential of "R" for statistical analysis of meteor data. "R" is a free software environment for statistical computing and graphics and runs on both UNIX and Windows platforms. It is used widely by data scientists and statisticians. The capabilities of "R" are extended by add-in packages which provide spe-

[2] `www.ukmeteorwatch.co.uk`

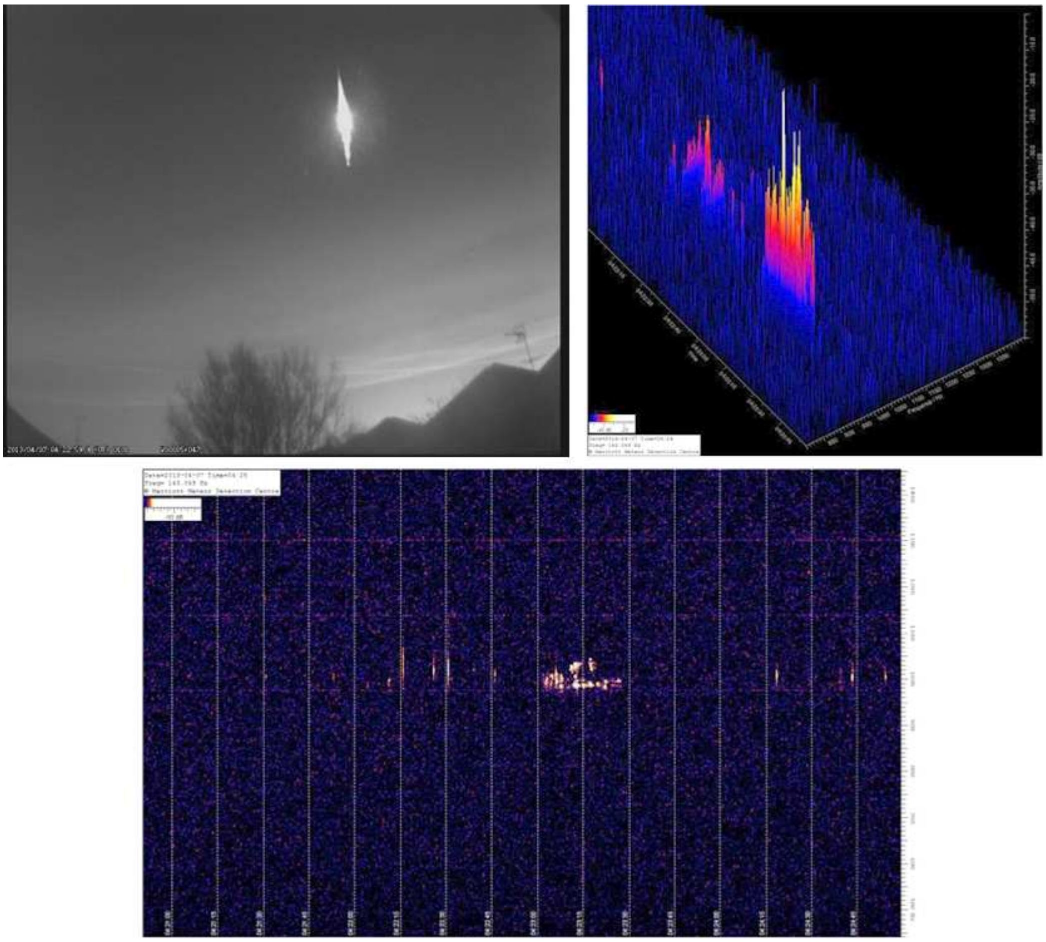

Figure 3 – Image of a bright sporadic meteor (top left) captured by the Ash Vale North camera and matched radio detections. The 2D visualisation (bottom) shows the radio signal reflected by the ionisation trail. The 3D plot (top right) translates the reflected wave into three parameters: amplitude (strength), frequency shift (Doppler shift) and decay time.

cialised statistical functions as well as extended graphics and reporting. UKMON aims to produce a library of standard analysis routines to produce a standard set of reports and graphs directly from `csv` files exported by UFO Orbit. "R" is supported by Integrated Development Environments and a web framework.

Improving the technology used across the network is an ongoing activity and work is underway to improve image resolution and sensitivity within the bounds of existing operational and financial constraints. The UKMON network uses predominantly the low-cost KPF 131 HR CCTV camera which offers only 720 × 576 resolution. Simultaneous trials of an alternative low-cost camera are underway by UKMON and EDMOND which uses a Sony-E 960H Exview CCD 1.3" sensor. This camera has increased resolution (920 × 582) and sensitivity compared to the KPF 131 HR. Alternative (faster) lenses are also being trialled. UKMON is in regular communication with its European colleagues who are also testing alternative cameras which could be used with UFO Capture suite.

Looking further ahead UKMON has an extensive project wish-list the implementation of which will be subject to available resources and priorities agreed by UKMON members. This wish list includes:

- Further development of the UKMON / UKMON Live websites and addition of new features.
- Full exploitation of UKMON data with more tangible outputs in the form of published papers and detailed web reports;
- Further development of the data archive:
  - Improvements to search and retrieval including filtering and selection,
  - Making an extended data set available to web users, and
  - Automated (on demand) summaries and statistics including graphical presentation.
- Addition of High definition video cameras into the UKMON network. The primary aim will be improved accuracy of data but an added benefit will be the availability of high resolution images for publication.
- Acquisition of meteor spectra. UKMON is already following closely the exploratory work being undertaken by CEMeNt and others.
- Central data archive,
- UKMON Live, and
- UKMON website and social media management.

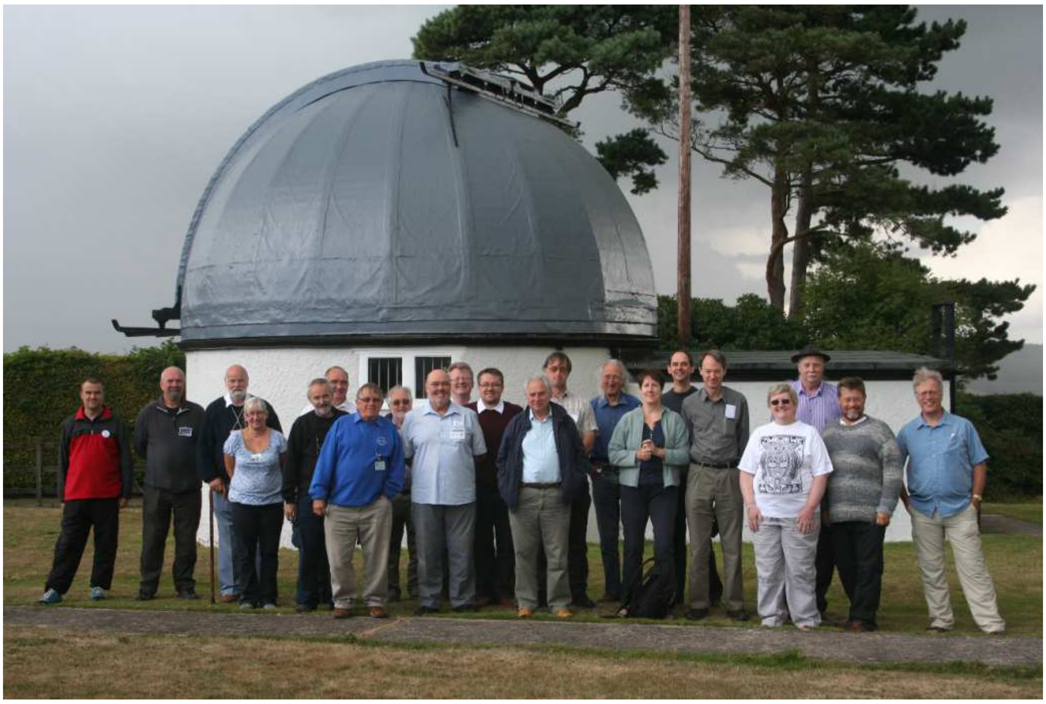

Figure 4 – Attendees at the first meeting of UKMON members at the Norman Lockyer Observatory, Sidmouth Devon, September 2013 (Photo: Graham Bryant, Hampshire Astronomical Group).

Ultimately, it is hoped to offer a full information set via the UKMON website including:

- Meteor video and composite image (although video may be limited to significant meteor events due to storage costs);
- Meteor radio spectra image and audio recording of the signal;
- Trajectory / orbit data based on multi-station observations.
- Meteor spectra.

8 Summary

Since the first camera became operational in 2012, the UKMON network has grown to 18 cameras with participation by 18 individuals. As of 2014 April 1 the UKMON archive holds data for over 18 900 individual meteor observations showing that UKMON is building a substantial dataset, UKMON is continuing to expand its network with more cameras planned to go on line in the coming months.

Use of the Internet is making citizen science more exciting, dynamic, interesting and accessible not something that is in reach of everyone. Members are able to participate at a level that best suits them, from just capturing meteors to participating in analysis and publishing reports.

Acknowledgements

The UKMON members and meteor station operators who have contributed to both the operation and organisation of UKMON and the data archive are listed in Table 3 below.

Handling Editor: Željko Andreić

Table 3 – UKMON members listed by affiliation.

Name	Affiliation
Martin Chicks Chris Hughes	Cardiff Astronomical Society
Peter Campbell-Burns	Farnham Astronomical Society
Peta Bosley Steve Bosley Steve Broadbent Graham Bryant	Hampshire Astronomical Group
Richard Fleet	Newbury Astronomical Society
Andy Exton	Scarborough and Ryedale Astronomy Society
Iain Grant Dave Jones Alan Shuttleworth Clive Vickery	Solar, Planetary and Meteor Detection Group
Steve Hooks	Independent
Richard Kacerek	Independent
Barry Lorimer	Independent
John Maclean	Independent

Results of the IMO Video Meteor Network — April 2014

Sirko Molau[1], *Javor Kac*[2], *Stefano Crivello*[3], *Enrico Stomeo*[4], *Geert Barentsen*[5], *Rui Goncalves*[6], *and Antal Igaz*[7]

In 2014 April, 81 cameras of the IMO Video Meteor Network accumulated over 7700 hours of effective observing time and recorded over 16 000 meteors. The flux density profile of the Lyrids is presented, based on the Network data covering years 2011–2014. The population index of the Lyrids is found to have a higher value at the time of maximum when compared to the periods before and after the maximum.

Received 2014 July 26

1 Introduction

April 2014 could not quite keep up with the record results of the previous month. Still, it provided us with the best April we have ever had. That is thanks to both the continuous high involvement in the IMO Network – once more we counted 81 active video cameras – and also thanks to the good weather conditions. Exactly half of the camera systems managed to observe in twenty or more nights, which is a great percentage for this capricious spring month. In the end we accumulated over 7 700 hours of effective observing time (Table 1 and Figure 1), which is 10% more than in the preceding year, and over 16 000 meteors, which is an increase of almost 15%.

After a break of several months, Wolfgang Hinz resumed his activities. He now operates a Mintron camera with 6 mm $f/0.75$ Panasonic lens under the name Hinwo1 at his Saxonian home town.

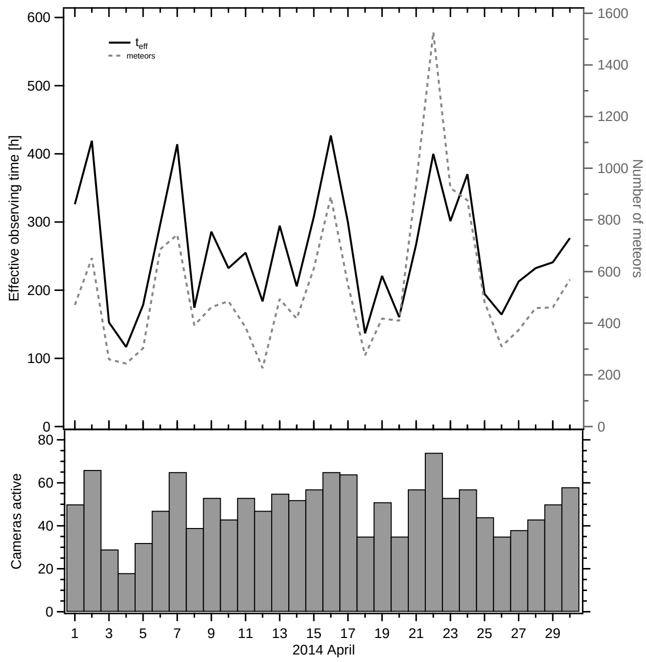

Figure 1 – Monthly summary for the effective observing time (solid black line), number of meteors (dashed gray line) and number of cameras active (bars) in 2014 April.

2 Lyrids

The Lyrids mark the end of a long period without ponderable meteor showers, and the Lyrids were the first shower for which we obtained flux densities three years ago (Molau et al., 2011). Even though the conditions were not perfect this year with the waning Moon illuminating morning skies, we now have data from four years and we can obtain a complete Lyrid activity profile. As can be seen in Figure 2, the 2014 data of the ascending branch fit well to the overall profile. In the descending branch, however, flux densities in 2014 are smaller than expected and lie a little below the imaginary connection line between 2011 and 2013 data.

Figure 3 shows the same data set of roughly 4 700 meteors, but this time averaged over all four years. The ascending branch shows lower scatter, whereas there are larger deviations in descending branch as expected from the lower rates in 2014. Peak activity occurred at $32\overset{\circ}{.}3$ solar longitude with a flux density of about 6 meteoroids per 1 000 km^2 per hour (at $\gamma = 1.9$).

2.1 Population index

The population index was determined for the peak night 2014 April 22/23 (729 Lyrids), as well as for the nights before and after the peak (359 and 187 Lyrids, respectively). Figure 4 shows clearly that the r-value was higher at the time of maximum ($r = 2.1$) than before and after ($r = 1.8$ and 1.7, respectively). That result is surprising at first, as many showers present an excess of bright meteors during the peak, i.e. the population index is decreasing. In our case, the data from all three nights are consistent, i.e. the intersection point of the individual graphs is well-defined.

A quick literature search taught us that our finding matches earlier investigations. Dubietis and Arlt (2001) had analysed visual Lyrid observations from 1988 to 2000. They found that the r-value increased in many years at the time of maximum, i.e. that the fraction of faint meteors was getting bigger. Their average peak time was at solar longitude $32\overset{\circ}{.}3$ as well.

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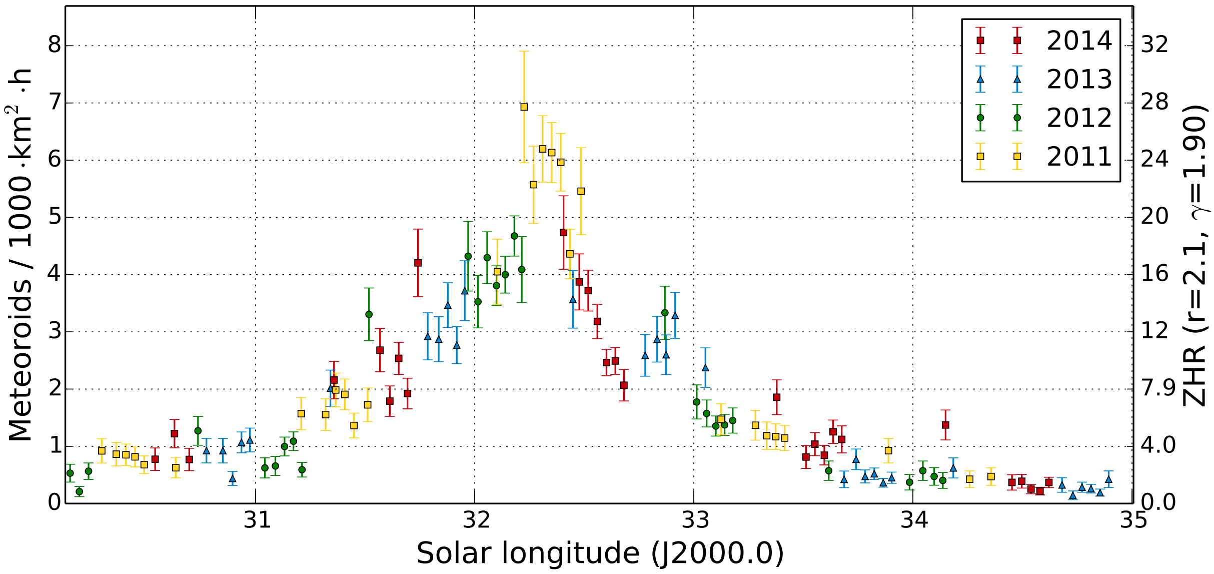

Figure 2 – Flux density profile of the Lyrids from the years 2011 till 2014, obtained from data of the IMO Video Meteor Network.

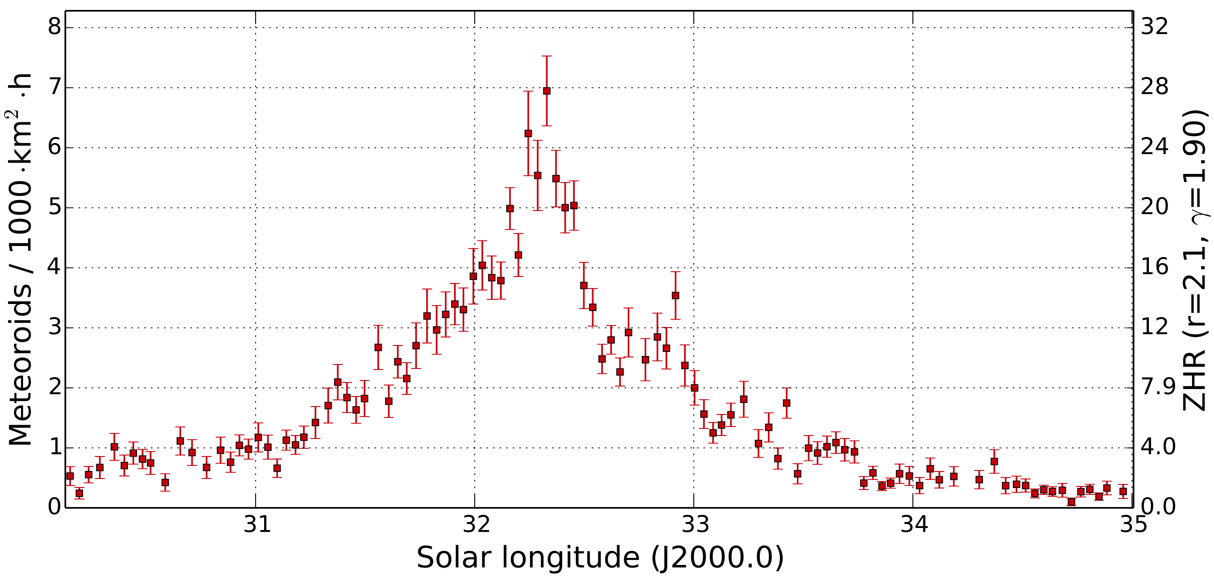

Figure 3 – Averaged flux density profile from the years 2011 till 2014.

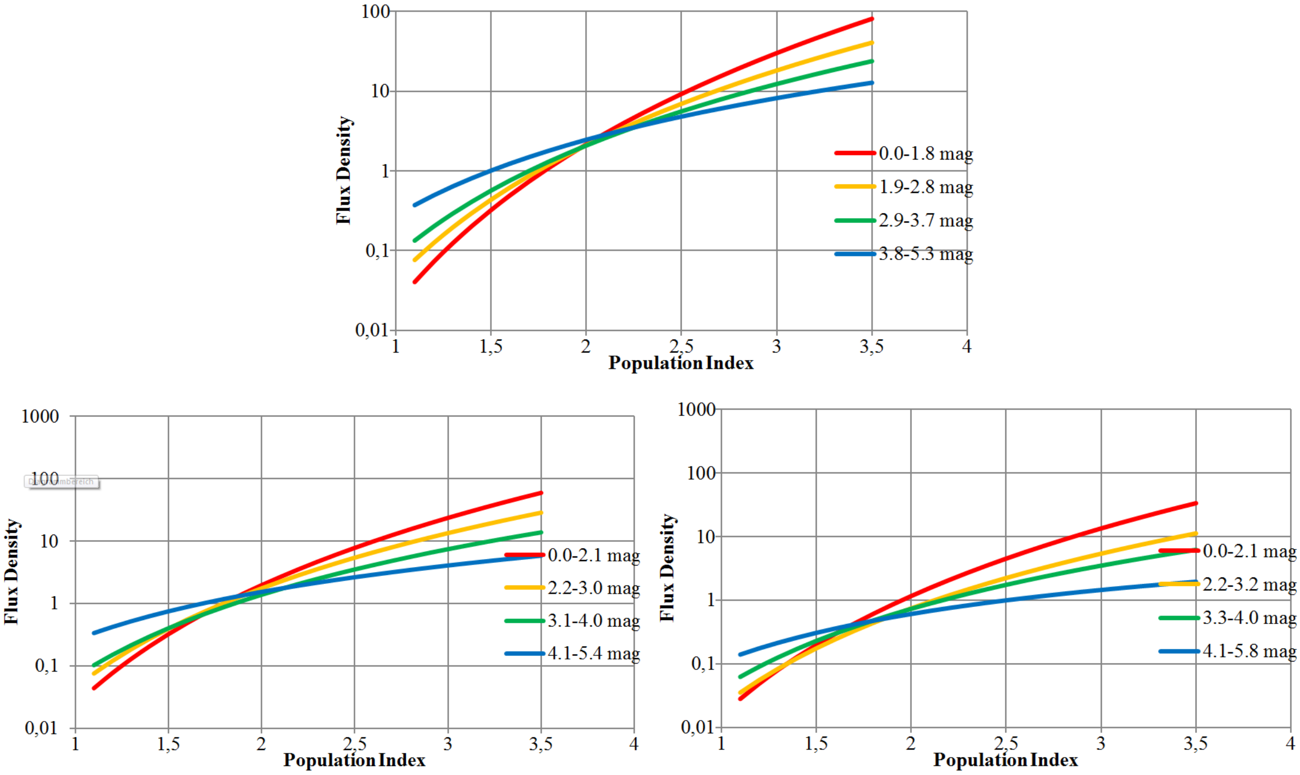

Figure 4 – Flux density of the Lyrids depending on the population index for different limiting magnitude classes. The intersection point of all curves yields the most probable r-value and flux density. Whereas the intersection point lies clearly right of the $r = 2.0$ line on 2014 April 22/23 (upper graph), it is located clearly left of that in the night before and after (left and right graph).

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Handling Editor: Javor Kac

Table 1 – Observers contributing to 2014 April data of the IMO Video Meteor Network. Eff.CA designates the effective collection area.

Code	Name	Place	Camera	FOV [°²]	Stellar LM [mag]	Eff.CA [km²]	Nights	Time [h]	Meteors
ARLRA	Arlt	Ludwigsfelde/DE	Ludwig2 (0.8/8)	1534	5.8	2467	21	103.8	289
BERER	Berkó	Ludányhalászi/HU	Hulud1 (0.8/3.8)	5542	4.8	3847	8	51.9	161
			Hulud3 (0.95/4)	4357	3.8	876	7	48.4	42
BOMMA	Bombardini	Faenza/IT	Mario (1.2/4.0)	5794	3.3	739	14	67.2	167
BREMA	Breukers	Hengelo/NL	Mbb3 (0.75/6)	2399	4.2	699	18	100.5	98
			Mbb4 (0.8/8)	1470	5.1	1208	14	61.4	73
BRIBE	Klemt	Herne/DE	Hermine (0.8/6)	2374	4.2	678	19	74.5	137
		Bergisch Gladbach/DE	Klemoi (0.8/6)	2286	4.6	1080	21	116.3	147
CASFL	Castellani	Monte Baldo/IT	Bmh1 (0.8/6)	2350	5.0	1611	20	130.6	249
			Bmh2 (1.5/4.5)*	4243	3.0	371	18	118.6	176
CRIST	Crivello	Valbrevenna/IT	Bilbo (0.8/3.8)	5458	4.2	1772	23	114.1	284
			C3P8 (0.8/3.8)	5455	4.2	1586	21	111.1	200
			Stg38 (0.8/3.8)	5614	4.4	2007	23	122.0	308
DONJE	Donani	Faenza/IT	Jenni (1.2/4)	5886	3.9	1222	23	148.5	351
ELTMA	Eltri	Venezia/IT	Met38 (0.8/3.8)	5631	4.3	2151	16	73.6	154
FORKE	Förster	Carlsfeld/DE	Akm3 (0.75/6)	2375	5.1	2154	18	92.3	184
GONRU	Goncalves	Tomar/PT	Templar1 (0.8/6)	2179	5.3	1842	19	138.3	307
			Templar2 (0.8/6)	2080	5.0	1508	23	160.8	281
			Templar3 (0.8/8)	1438	4.3	571	22	156.3	132
			Templar4 (0.8/3.8)	4475	3.0	442	23	151.6	261
			Templar5 (0.75/6)	2312	5.0	2259	23	150.2	257
GOVMI	Govedič	Središče ob Dravi/SI	Orion2 (0.8/8)	1447	5.5	1841	19	86.7	111
			Orion3 (0.95/5)	2665	4.9	2069	14	53.4	56
			Orion4 (0.95/5)	2662	4.3	1043	17	55.9	80
HERCA	Hergenrother	Tucson/US	Salsa3 (1.2/4)*	2198	4.6	894	28	240.2	330
HINWO	Hinz	Schwarzenberg/DE	Hinwo1 (0.75/6)	2291	5.1	1819	9	31.8	95
IGAAN	Igaz	Baja/HU	Hubaj (0.8/3.8)	5552	2.8	403	18	96.7	101
		Debrecen/HU	Hudeb (0.8/3.8)	5522	3.2	620	23	108.7	130
		Hódmezővásárhely/HU	Huhod (0.8/3.8)	5502	3.4	764	16	76.9	75
		Budapest/HU	Hupol (1.2/4)	3790	3.3	475	16	90.8	46
JONKA	Jonas	Budapest/HU	Husor (0.95/4)	2286	3.9	445	23	117.1	111
KACJA	Kac	Ljubljana/SI	Orion1 (0.8/8)	1402	3.8	331	10	32.1	20
		Kamnik/SI	Cvetka (0.8/3.8)*	4914	4.3	1842	16	87.0	219
			Rezika (0.8/6)	2270	4.4	840	16	88.4	317
			Stefka (0.8/3.8)	5471	2.8	379	16	88.2	179
KISSZ	Kiss	Sülysáp/HU	Husul (0.95/5)*	4295	3.0	355	17	74.3	47
KOSDE	Koschny	Izana Obs./ES	Icc7 (0.85/25)*	714	5.9	1464	11	58.1	449
		La Palma/ES	Icc9 (0.85/25)*	683	6.7	2951	22	167.9	1174
		Noordwijkerhout/NL	Lic4 (1.4/50)*	2027	6.0	4509	21	101.5	153
LOJTO	Łojek	Grabniak/PL	Pav57 (1.0/5)	1631	3.5	269	15	84.7	70

Table 1 – Observers contributing to 2014 April data of the IMO Video Meteor Network – continued from previous page.

Code	Name	Place	Camera	FOV [°²]	Stellar LM [mag]	Eff.CA [km²]	Nights	Time [h]	Meteors
MACMA	Maciejewski	Chełm/PL	Pav35 (0.8/3.8)	5495	4.0	1584	21	120.5	275
			Pav36 (0.8/3.8)*	5668	4.0	1573	21	120.6	339
			Pav43 (0.75/4.5)*	3132	3.1	319	11	54.7	68
			Pav60 (0.75/4.5)	2250	3.1	281	8	48.5	79
MASMI	Maslov	Novosibirsk/RU	Nowatec (0.8/3.8)	5574	3.6	773	22	100.7	215
MOLSI	Molau	Seysdorf/DE	Avis2 (1.4/50)*	1230	6.9	6152	22	122.4	557
			Mincam1 (0.8/8)	1477	4.9	1084	23	126.3	211
		Ketzür/DE	Remo1 (0.8/8)	1467	6.5	5491	22	92.6	409
			Remo2 (0.8/8)	1478	6.4	4778	22	109.2	325
			Remo3 (0.8/8)	1420	5.6	1967	12	48.5	47
			Remo4 (0.8/8)	1478	6.5	5358	24	110.5	409
MORJO	Morvai	Fülöpszállás/HU	Huful (1.4/5)	2522	3.5	532	20	118.1	92
MOSFA	Moschner	Rovereto/IT	Rover (1.4/4.5)	3896	4.2	1292	21	72.8	176
OCHPA	Ochner	Albiano/IT	Albiano (1.2/4.5)	2944	3.5	358	14	105.6	156
OTTMI	Otte	Pearl City/US	Orie1 (1.4/5.7)	3837	3.8	460	19	67.9	232
PERZS	Perkó	Becsehely/HU	Hubec (0.8/3.8)*	5498	2.9	460	19	100.2	206
PUCRC	Pucer	Nova vas nad Dragonjo/SI	Mobcam1 (0.75/6)	2398	5.3	2976	21	96.2	119
ROTEC	Rothenberg	Berlin/DE	Armefa (0.8/6)	2366	4.5	911	11	58.4	60
SARAN	Saraiva	Carnaxide/PT	Ro1 (0.75/6)	2362	3.7	381	19	123.6	144
			Ro2 (0.75/6)	2381	3.8	459	23	146.8	203
			Ro3 (0.8/12)	710	5.2	619	23	154.2	315
			Sofia (0.8/12)	738	5.3	907	20	129.9	106
SCALE	Scarpa	Alberoni/IT	Leo (1.2/4.5)*	4152	4.5	2052	16	67.9	122
SCHHA	Schremmer	Niederkrüchten/DE	Doraemon (0.8/3.8)	4900	3.0	409	22	115.9	216
SLAST	Slavec	Ljubljana/SI	Kayak1 (1.8/28)	563	6.2	1294	9	30.9	20
STOEN	Stomeo	Scorze/IT	Min38 (0.8/3.8)	5566	4.8	3270	24	100.1	396
			Noa38 (0.8/3.8)	5609	4.2	1911	23	111.7	324
			Sco38 (0.8/3.8)	5598	4.8	3306	25	124.6	458
STORO	Štork	Kunžak/CZ	Kun1 (1.4/50)*	1913	5.4	2778	4	21.6	219
		Ondřejov/CZ	Ond1 (1.4/50)*	2195	5.8	4595	4	22.0	254
STRJO	Strunk	Herford/DE	Mincam2 (0.8/6)	2354	5.4	2751	22	107.5	185
			Mincam3 (0.8/6)	2338	5.5	3590	22	106.0	202
			Mincam4 (1.0/2.6)	9791	2.7	552	18	56.1	102
			Mincam5 (0.8/6)	2349	5.0	1896	21	99.5	167
			Mincam6 (0.8/6)	2395	5.1	2178	21	103.1	182
TEPIS	Tepliczky	Agostyán/HU	Huago (0.75/4.5)	2427	4.4	1036	20	122.2	135
		Budapest/HU	Humob (0.8/6)	2388	4.8	1607	24	113.2	193
TRIMI	Triglav	Velenje/SI	Sraka (0.8/6)*	2222	4.0	546	17	45.3	98
YRJIL	Yrjölä	Kuusankoski/FI	Finexcam (0.8/6)	2337	5.5	3574	24	117.4	221
ZELZO	Zelko	Budapest/HU	Huvcse03 (1.0/4.5)	2224	4.4	933	5	11.3	21
			Huvcse04 (1.0/4.5)	1484	4.4	573	5	10.9	21
* active field of view smaller than video frame						Overall	30	7 747.8	16 300

Results of the IMO Video Meteor Network — May 2014

Sirko Molau[1], *Javor Kac*[2], *Stefano Crivello*[3], *Enrico Stomeo*[4], *Geert Barentsen*[5], *Rui Goncalves*[6], *and Antal Igaz*[7]

In 2014 May, over 18 000 meteors were recorded in almost 7 700 hours of effective observing time by 81 cameras of the IMO Video Meteor Network. The flux density profile of the η-Aquariids is presented over the full activity period, based on over 5 000 shower meteors recorded over the last four years. The activity profile is also presented for the η-Lyrids, based on data obtained during the years 2011 to 2014.

Received 2014 September 5

1 Introduction

The pleasant spring weather continued in May 2014. Everywhere in Europe the observers could enjoy many clear nights. 75 video systems were active on May 5, and 47 out of the overall 81 cameras managed to obtain observations in twenty or more observing nights. Enrico Stomeo missed only one night with his camera Sco38, and Carl Hergenrother (who is currently on top of the 2014 observing statistics with a margin of five nights) had to pause just two nights with his camera Salsa3. Under such excellent conditions it is no surprise that we collected almost 7 500 hours of effective observing time (Table 1 and Figure 1), which is a 20% increase compared to the previous best May of 2012. With over 18 000 meteors, the meteor count also increased by 20% compared to 2012.

There were no new cameras in May, but Maciej Maciejewski provided most of his video equipment for a Camelopardalid expedition to Canada. Everyone knows that the hoped-for outburst did not materialize (at least not for visual and video observers) – still it is worthwhile to have a quick look at the collected data. Peter Brown reported that the Camelopardalids were prominent in the Canadian CMOR radar, which confirms the predicted outburst (Brown, 2014). However, most recorded echoes were underdense, i.e. the outburst was rich in faint meteors. Based on the IMO quick-look analysis (International Meteor Organization, 2014), the peak ZHR hardly reached 20, and also the meteor cameras in America recorded only few shower meteors. Even the airborne campaign of Peter Jenniskens had to content with roughly 20 Camelopardalids (Jenniskens, 2014), and also the full IMO Network could record only about 30 shower members on May 23/24. It is impossible to obtain an activity profile from such a small data set.

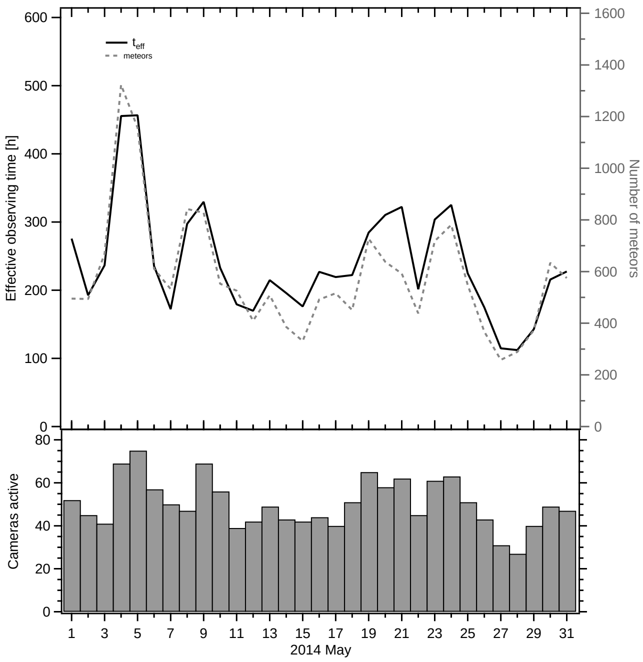

Figure 1 – Monthly summary for the effective observing time (solid black line), number of meteors (dashed gray line) and number of cameras active (bars) in 2014 May.

The η-Aquariids and η-Lyrids had better visibility. The first shower is always challenging for the observers in the IMO Network, because for most of the cameras it becomes visible only in the morning twilight and most meteors are recorded at low radiant altitudes.

2 η-Aquariids

Let us first look at a summary profile with low temporal resolution, calculated from over 5 000 η-Aquariids recorded in the last four years (Figure 2). It shows an almost symmetric profile with a peak at 46°.3 solar longitude and a peak flux density of almost 50 meteoroids per 1 000 km^2 per hour (at $\gamma = 1.5$).

Looking at the individual years, the picture becomes more differentiated (Figure 3). The unusual peak of 2013 is easily visible, and so is a shift of the 2014 activity profile. Both the ascending and descending activity branch were a little later in this year than in the previous.

The limits become visible in a high resolution graph of the 2014 peak (Figure 4). Whereas there is only little scatter at the begin of the observing window, when the radiant is lowest in the sky, the rates increase rapidly

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NASA-ADS bibcode 2014JIMO...42..150M

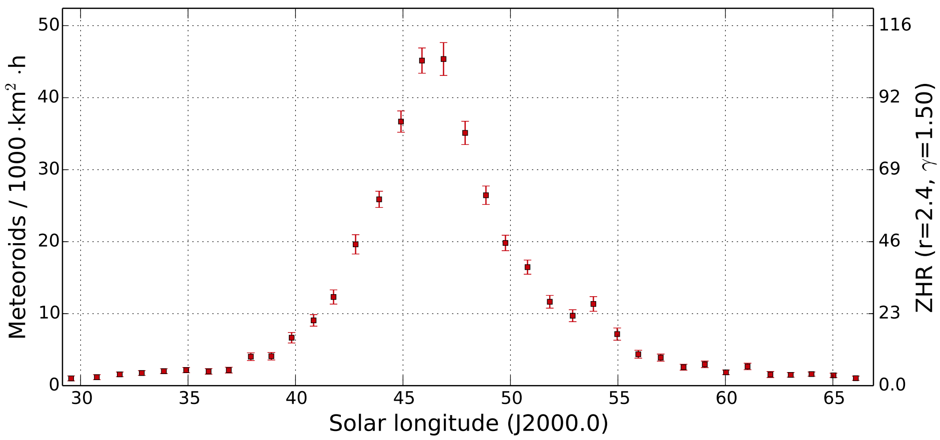

Figure 2 – Overall activity profile of the η-Aquariids from flux density measures in the IMO Video Meteor Network 2011 till 2014.

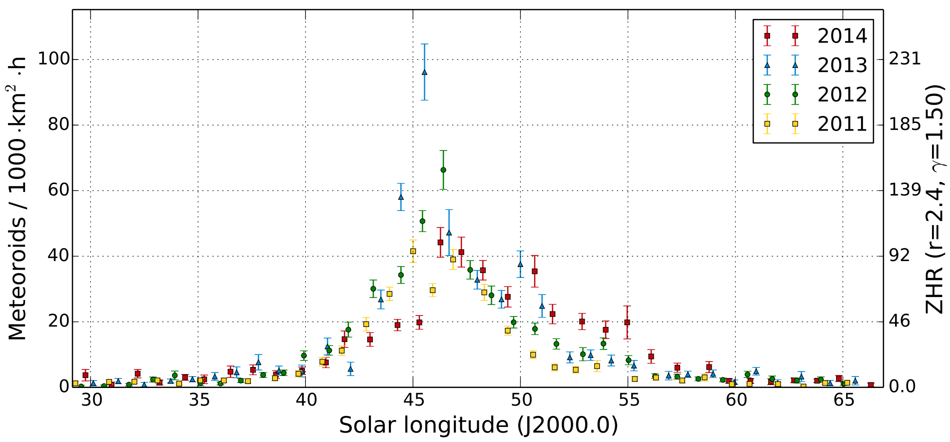

Figure 3 – Activity profile of the η-Aquariids, separated for the years 2011 till 2014.

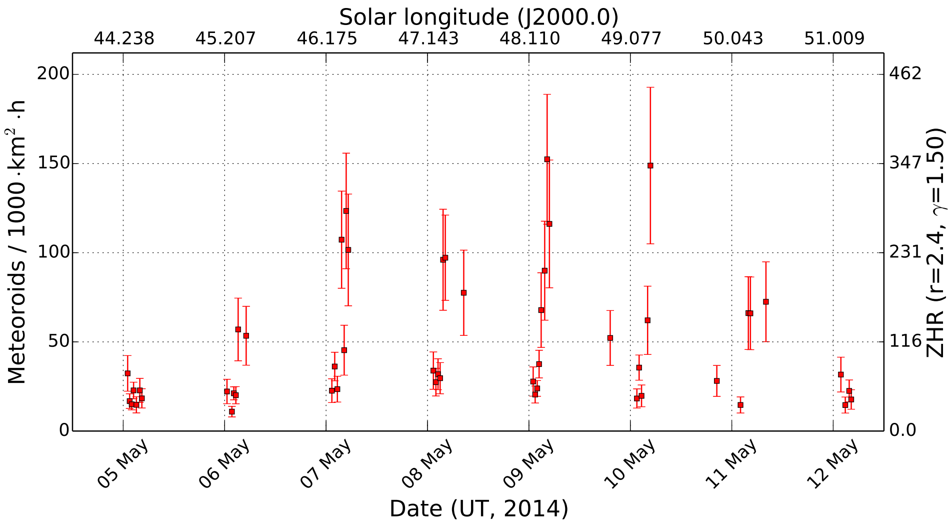

Figure 4 – High resolution activity profile from the peak of the η-Aquariids in 2014.

towards the end of the observing window. That cannot be explained by the zenith exponent, since it has the biggest impact on the first few intervals. As the effect was not observed in previous years it can be speculated that this is just a selection effect (i.e. that different cameras dominated at the end of the night than at the begin). Unfortunately, the fluxviewer does not currently have the options to select or reject individual cameras to easily substantiate this hypothesis.

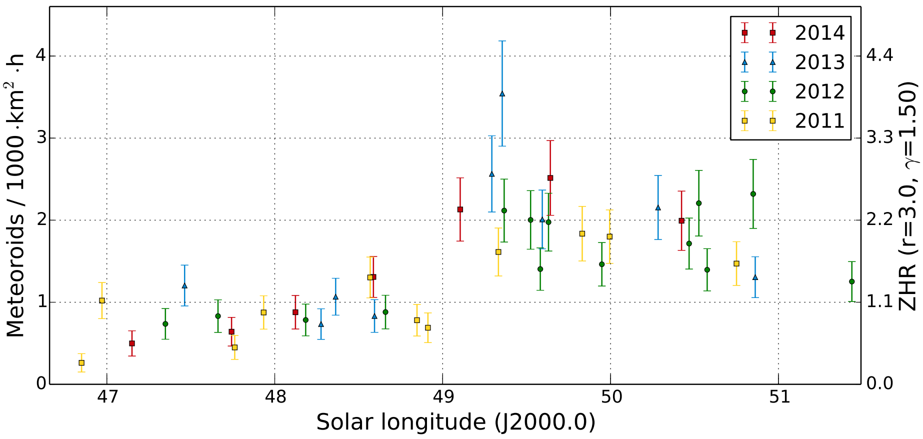

Figure 5 – Activity profile of the η-Lyrids, separated for the years 2011 till 2014.

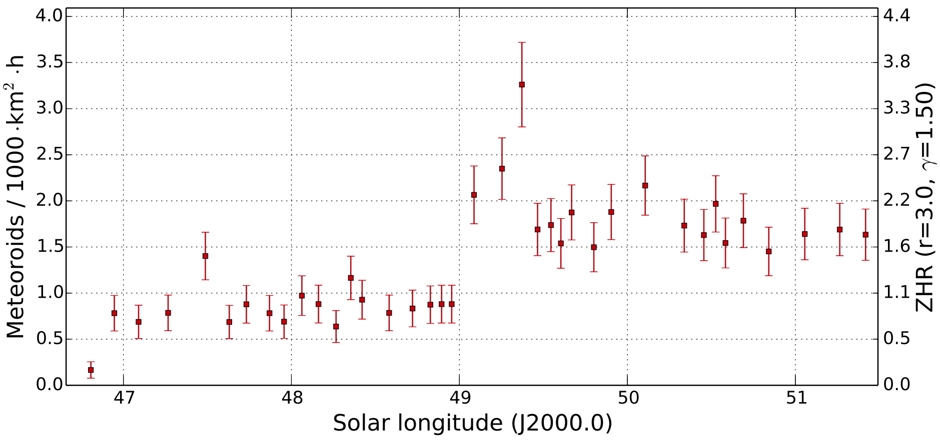

Figure 6 – Overall activity profile of the η-Lyrids from data between 2011 and 2014.

3 η-Lyrids

The η-Lyrids, which are active only a few days later, show an unusual activity profile. It is consistent over the last four years and statistically on quite solid ground with over 1 000 shower members. Up to a solar longitude of 49°, the shower hardly stands out from the sporadic background. Thereafter the flux density jumps suddenly by a factor of two, but instead of a clear peak, the activity remains almost constant for over two days (Figure 5). With some uncertainty, the averaged activity profile yields a peak at 49.°4 solar longitude (Figure 6).

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Handling Editor: Javor Kac

Table 1 – Observers contributing to 2014 May data of the IMO Video Meteor Network. Eff.CA designates the effective collection area.

Code	Name	Place	Camera	FOV [$^{\circ 2}$]	Stellar LM [mag]	Eff.CA [km^2]	Nights	Time [h]	Meteors
ARLRA	Arlt	Ludwigsfelde/DE	Ludwig2 (0.8/8)	1475	6.2	3779	22	87.9	411
BERER	Berkó	Ludányhalászi/HU	Hulud1 (0.8/3.8)	5542	4.8	3847	12	68.2	226
			Hulud3 (0.95/4)	4357	3.8	876	6	31.9	27
BOMMA	Bombardini	Faenza/IT	Mario (1.2/4.0)	5794	3.3	739	24	107.4	426
BREMA	Breukers	Hengelo/NL	Mbb3 (0.75/6)	2399	4.2	699	12	55.5	75
			Mbb4 (0.8/8)	1470	5.1	1208	20	85.8	100
BRIBE	Klemt	Herne/DE	Hermine (0.8/6)	2374	4.2	678	12	60.9	110
		Bergisch Gladbach/DE	Klemoi (0.8/6)	2286	4.6	1080	22	98.4	166
CASFL	Castellani	Monte Baldo/IT	Bmh1 (0.8/6)	2350	5.0	1611	24	127.7	228
			Bmh2 (1.5/4.5)*	4243	3.0	371	22	111.5	152
CRIST	Crivello	Valbrevenna/IT	Bilbo (0.8/3.8)	5458	4.2	1772	24	135.1	276
			C3P8 (0.8/3.8)	5455	4.2	1586	26	108.9	148
			Stg38 (0.8/3.8)	5614	4.4	2007	26	146.6	337
DONJE	Donani	Faenza/IT	Jenni (1.2/4)	5886	3.9	1222	27	152.9	618
ELTMA	Eltri	Venezia/IT	Met38 (0.8/3.8)	5631	4.3	2151	19	91.4	205
FORKE	Förster	Carlsfeld/DE	Akm3 (0.75/6)	2375	5.1	2154	15	51.5	113
GONRU	Goncalves	Tomar/PT	Templar1 (0.8/6)	2179	5.3	1842	18	115.2	362
			Templar2 (0.8/6)	2080	5.0	1508	25	167.7	337
			Templar3 (0.8/8)	1438	4.3	571	26	160.7	191
			Templar4 (0.8/3.8)	4475	3.0	442	25	161.1	339
			Templar5 (0.75/6)	2312	5.0	2259	27	140.7	314
GOVMI	Govedič	Središče ob Dravi/SI	Orion2 (0.8/8)	1447	5.5	1841	20	105.4	234
			Orion3 (0.95/5)	2665	4.9	2069	18	63.5	95
			Orion4 (0.95/5)	2662	4.3	1043	21	90.5	141
HERCA	Hergenrother	Tucson/US	Salsa3 (1.2/4)*	2198	4.6	894	29	238.3	376
HINWO	Hinz	Schwarzenberg/DE	Hinwo1 (0.75/6)	2291	5.1	1819	13	50.5	117
IGAAN	Igaz	Baja/HU	Hubaj (0.8/3.8)	5552	2.8	403	21	111.4	117
		Debrecen/HU	Hudeb (0.8/3.8)	5522	3.2	620	21	110.7	145
		Hódmezővásárhely/HU	Huhod (0.8/3.8)	5502	3.4	764	21	105.4	100
		Budapest/HU	Hupol (1.2/4)	3790	3.3	475	8	38.4	22
JONKA	Jonas	Budapest/HU	Husor (0.95/4)	2286	3.9	445	21	96.7	102
KACJA	Kac	Ljubljana/SI	Orion1 (0.8/8)	1402	3.8	331	19	85.5	71
		Kamnik/SI	Cvetka (0.8/3.8)*	4914	4.3	1842	16	81.1	255
			Rezika (0.8/6)	2270	4.4	840	19	100.2	379
			Stefka (0.8/3.8)	5471	2.8	379	14	73.8	151
		Kostanjevec/SI	Metka (0.8/12)*	715	6.4	640	6	40.8	89
KISSZ	Kiss	Sülysáp/HU	Husul (0.95/5)*	4295	3.0	355	16	59.3	41
KOSDE	Koschny	Izana Obs./ES	Icc7 (0.85/25)*	714	5.9	1464	25	182.5	1340
		La Palma/ES	Icc9 (0.85/25)*	683	6.7	2951	26	182.1	1514
		Noordwijkerhout/NL	Lic4 (1.4/50)*	2027	6.0	4509	22	79.2	170
LOJTO	Łojek	Grabniak/PL	Pav57 (1.0/5)	1631	3.5	269	13	58.3	50

Table 1 – Observers contributing to 2014 May data of the IMO Video Meteor Network – continued from previous page.

Code	Name	Place	Camera	FOV [°²]	Stellar LM [mag]	Eff.CA [km²]	Nights	Time [h]	Meteors
MACMA	Maciejewski	Chełm/PL	Pav35 (0.8/3.8)	5495	4.0	1584	7	26.8	70
			Pav36 (0.8/3.8)*	5668	4.0	1573	8	32.7	91
			Pav43 (0.75/4.5)*	3132	3.1	319	20	86.2	83
MASMI	Maslov	Novosibirsk/RU	Nowatec (0.8/3.8)	5574	3.6	773	20	56.4	176
MOLSI	Molau	Seysdorf/DE	Avis2 (1.4/50)*	1230	6.9	6152	19	70.0	513
			Mincam1 (0.8/8)	1477	4.9	1084	19	85.5	164
		Ketzür/DE	Remo1 (0.8/8)	1467	6.5	5491	23	101.9	437
			Remo2 (0.8/8)	1478	6.4	4778	23	99.9	297
			Remo3 (0.8/8)	1420	5.6	1967	17	64.1	58
			Remo4 (0.8/8)	1478	6.5	5358	24	102.1	414
MORJO	Morvai	Fülöpszállás/HU	Huful (1.4/5)	2522	3.5	532	20	113.8	101
MOSFA	Moschner	Rovereto/IT	Rover (1.4/4.5)	3896	4.2	1292	26	49.5	185
OCHPA	Ochner	Albiano/IT	Albiano (1.2/4.5)	2944	3.5	358	21	130.4	143
OTTMI	Otte	Pearl City/US	Orie1 (1.4/5.7)	3837	3.8	460	20	62.5	180
PERZS	Perkó	Becsehely/HU	Hubec (0.8/3.8)*	5498	2.9	460	21	110.5	295
PUCRC	Pucer	Nova vas nad Dragonjo/SI	Mobcam1 (0.75/6)	2398	5.3	2976	23	99.8	177
ROTEC	Rothenberg	Berlin/DE	Armefa (0.8/6)	2366	4.5	911	17	83.7	67
SARAN	Saraiva	Carnaxide/PT	Ro1 (0.75/6)	2362	3.7	381	27	160.8	215
			Ro2 (0.75/6)	2381	3.8	459	27	169.3	269
			Ro3 (0.8/12)	710	5.2	619	27	183.0	452
			Sofia (0.8/12)	738	5.3	907	25	162.9	181
SCALE	Scarpa	Alberoni/IT	Leo (1.2/4.5)*	4152	4.5	2052	17	70.3	102
SCHHA	Schremmer	Niederkrüchten/DE	Doraemon (0.8/3.8)	4900	3.0	409	22	83.0	157
SLAST	Slavec	Ljubljana/SI	Kayak1 (1.8/28)	563	6.2	1294	11	38.9	26
STOEN	Stomeo	Scorze/IT	Min38 (0.8/3.8)	5566	4.8	3270	28	99.5	374
			Noa38 (0.8/3.8)	5609	4.2	1911	27	111.2	321
			Sco38 (0.8/3.8)	5598	4.8	3306	30	120.4	437
STORO	Štork	Kunžak/CZ	Kun1 (1.4/50)*	1913	5.4	2778	3	14.2	113
		Ondřejov/CZ	Ond1 (1.4/50)*	2195	5.8	4595	3	14.5	124
STRJO	Strunk	Herford/DE	Mincam2 (0.8/6)	2354	5.4	2751	20	78.4	167
			Mincam3 (0.8/6)	2338	5.5	3590	22	77.4	180
			Mincam4 (1.0/2.6)	9791	2.7	552	18	69.3	83
			Mincam5 (0.8/6)	2349	5.0	1896	20	75.6	146
			Mincam6 (0.8/6)	2395	5.1	2178	19	71.0	113
TEPIS	Tepliczky	Agostyán/HU	Huago (0.75/4.5)	2427	4.4	1036	19	85.2	89
		Budapest/HU	Humob (0.8/6)	2388	4.8	1607	19	82.4	153
TRIMI	Triglav	Velenje/SI	Sraka (0.8/6)*	2222	4.0	546	20	40.3	151
YRJIL	Yrjölä	Kuusankoski/FI	Finexcam (0.8/6)	2337	5.5	3574	5	13.1	29
ZELZO	Zelko	Budapest/HU	Huvcse03 (1.0/4.5)	2224	4.4	933	7	15.4	33
			Huvcse04 (1.0/4.5)	1484	4.4	573	6	15.5	26
* active field of view smaller than video frame						Overall	31	7 448.0	18 062

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